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KEY POINTS IN LUNG STRUCTURE[1]

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SOMETHING more is required of the physician than a knowledge of the various methods embraced under the generic term "physical diagnosis"; something more is required of the radiologist than a knowledge of electricity. This "something" which should be thoroughly understood, is a knowledge of pulmonary structure. While under the stimulus of these and various other interests, considerable advance has been made, there remains much that needs to be done.

I have chosen for the subject of my paper "Key Points in Lung Structure," because, whether it be from the standpoint of normal or of pathological histology, they are of great assistance in understanding the architecture of the lung. This is, at the present time, of great importance; for the gross structure of the lung is quite well known.

If the subdivisions of the bronchial tree be followed within the lung, a point is eventually reached where the bronchioli lose their circular outline on section and alveoli in varying number may be seen opening into their lumen. A bronchiolus of this character is called a *bronchiolus respiratorius* (respiratory bronchiole), because by means of the alveoli it takes a certain part in the act of respiration. There are usually two or three orders of bronchioli of this character in the human lung (Fig. 1 *B*, and Fig. 6, *br. resp.*). The more distal order of the bronchioli respiratorii divide into two branches, which have a larger number of alveoli opening into them than is the case with the bronchioli from which they arise (Fig. 1, *d. al.*, and Fig. 6, *d. al.*); these are

Fig. 1. Scheme of a primary lobule with its blood vessels and lymphatics. *P.*, pleura; *Br.*, bronchiolus respiratorius which divides into two ductuli alveolares (*d. al.*), only one of which is carried out in detail; *a. a. a.*, three atria, each of which has a number of sacculi alveolares (*s. al.*), opening into it around the periphery of which are the alveoli pulmonis, *c.* Alveoli are also connected with the bronchiolus respiratorius, ductulus alveolaris and the atria. *A.*, pulmonary artery which divides into three atrial branches and each atrial branch divides into branches which are distributed to the sacculi alveolares; these latter branches give origin to the capillary network in the walls of the air spaces. *L.*, lymphatics; *V.*, pulmonary vein and its branches of origin; *1, 2, 3, 4, 5,* the key points described in the text. The bronchial artery does not extend as far as the primary lobule; for the nerves, see Figure 6. (After Miller, *Amer. Rev. Tuberc.*, 1919, III, 65.)

[1] Read before the Radiological Society of North America, at Kansas City, December, 1924.

called *ductuli alveolares* (alveolar passages).

Each ductulus alveolaris has connected with its distal end from two to five spheroidal cavities, the *atria* (Fig. 1, *a.*); each atrium has opening into it a variable number of air spaces, the *sacculi alveolares* (air sacs), and each sacculus (Fig. 1, *s. al.*) has projecting from its surface numerous smaller air spaces (Fig. 1, *c.*), the *alveoli pulmonis* (air cells). Alveoli are, therefore, connected with all the air spaces distal to the last bronchiolus with smooth walls. *A ductulus alveolaris, the air spaces connected with it, and all their associated vessels and nerves, constitute the primary lobule* (anatomical unit).

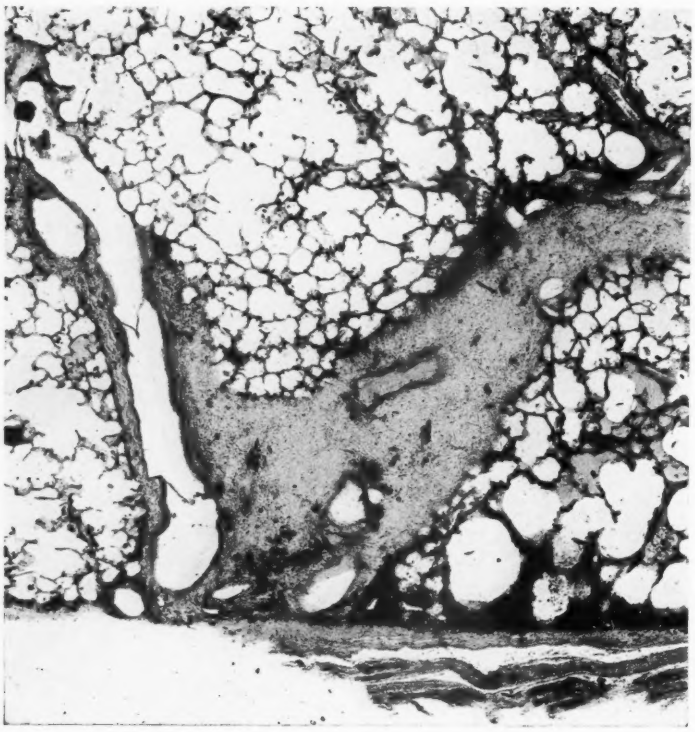

Fig. 2. Photograph of a section of a human lung in which valves may be seen pointing (opening) towards the pleura. The lymphatic is situated in a septum. The oval opening at the right of the lower end of the lymphatic is a section of a pulmonary vein. (After Miller, *Amer. Rev. Tuberc.*, 1919, III, 193.)

The lungs receive their blood supply from two sources: the pulmonary artery and the bronchial artery. The *pulmonary artery* follows the subdivisions of the bronchial tree until it reaches the distal end of the ductuli alveolares; here it breaks up into as many branches as there are atria connected with the ductuli alveolares; each atrial branch divides into as many branches as there are air sacs connected with the atrium to which it belongs; both atrial and air sac branches eventually terminate in a plexus of capillaries that is situated in the walls of the air spaces. The blood brought to the lungs by the pulmonary artery is returned by the pulmonary veins. The *bronchial artery* is the nutrient artery of the lungs; it is distributed to the walls of the bronchi and bronchioli, the connective tissue within the lungs, the lymphoid tissue, and, in lungs which have a thick pleura, to

the pleura. Its blood is returned by the pulmonary veins, except from a limited area about the hilum where true bronchial veins are found.

The surface of the lung is covered by the pleura. Certain points connected with its structure need consideration at this time, though full details must be omitted. The pleura may be of considerable thickness, as in man; or it may be of much less thickness, as in the dog. In the former case, septa are present within the lung; these mark out the secondary lobules, and it is along these septa that branches of the bronchial artery reach the pleura and furnish its vascular supply. In the latter case, no septa are present and the pleura receives its blood supply from the pulmonary artery. In each instance it is the pulmonary vein that returns the blood from the pleura. In addition to the blood vessels the pleura contains a rich plexus of lymphatics which have their own vascular supply, the source of which depends on the thickness of the pleura. In animals with a thick pleura it is from the bronchial artery; in animals with a thin pleura it is from the pulmonary artery.

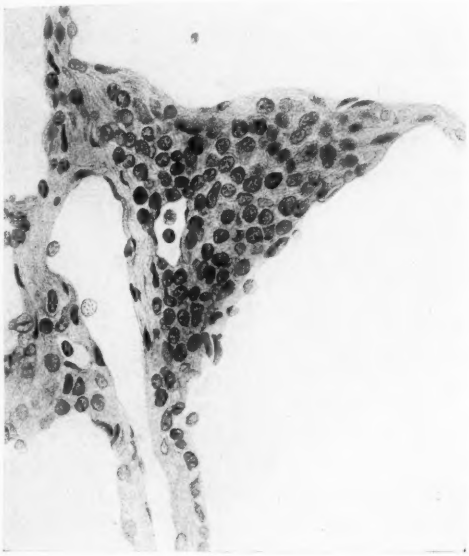

Fig. 3. Lymphoid tissue at the junction of a small vein which arises from the distal end of a ductulus alveolaris with a larger one situated on the periphery of the lobule. See also Figure 5 for the course of this vein.

This preliminary, but important, description of lung architecture necessarily precedes the taking up in detail of the key points (Fig. 1: 1, 2, 3, 4, 5). These will be considered very concisely in their relation to the human lung; though they are also applicable, with but slight modification, to all mammalian lungs. The five points are as follows:

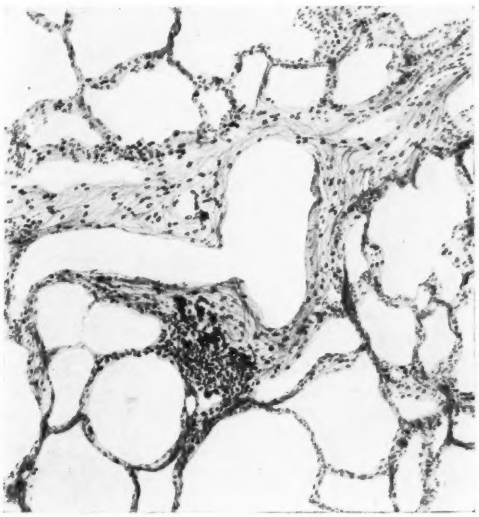

Fig. 4. Lymphoid tissue at the junction of a vein arising from the place where a bronchiolus divided, with a larger vein situated in a septum. (After Miller, *Anatom. Record*, 1911, V, 99.)

(1) The place where radicals of the pulmonary vein arise from the pleura.

(2) The place where radicals of the pulmonary vein arising from the distal end of a ductulus alveolaris join a venous trunk situated on the periphery of a primary lobule.

(3) The place where radicals of the pulmonary vein arising from the place where bronchi or bronchioli divide, join a larger trunk which may, or may not, be situated on the periphery of a secondary lobule.

(4) The distal end of a ductulus alveolaris.

(5) The place where a bronchus or a bronchiolus divides.

While the following statements are based on what may be found in the human lung,

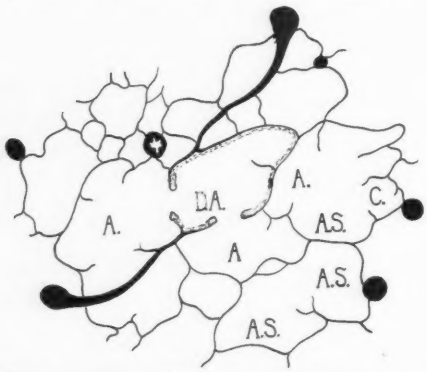

Fig. 5. Camera lucida tracing of a section through a ductulus alveolaris, atria and sacculi alveolares. *D. A.*, ductulus alveolaris; *A, A, A,* three atria; *A. S.*, sacculi alveolares; *C.*, an alveolus pulmonis. The two sacculi at the lower part of the tracing eventually become divided into two independent sacculi and communicate by individual openings with the atrium situated just above them. The pulmonary veins are indicated in solid black; the pulmonary artery is the vessel with a stellate opening. The two veins which arise from the distal end of a ductulus alveolaris are shown cut through their full length. The muscle is indicated cut lengthwise by short lines and by dots when cut transversely. Note that about the openings leading into the atria the muscle is cut transversely, thus showing that it was arching around the opening in the form of a sphincter. (After Miller, *Anatom. Anz.*, 1892, VII, 181.)

they are also applicable, with but slight modification, to all mammalian lungs.

At Point 1, the connective tissue septa join the pleura; branches of the bronchial artery pass to the pleura and break up into a network of capillaries; the small venous radicals which arise from this network of capillaries unite to form a small vein that passes along the septum into the depth of the lung; the lymphatics which are situated in the septum join the plexus of lymphatics in the pleura, the direction of the lymph flow being towards the pleura, as indicated by the position of the valves (Fig. 2); lymphoid tissue is found; nerve trunks are often found.

At Point 2, the small vein arising from the distal end of a ductulus alveolaris joins a larger trunk; the lymphatics which accompany this vein join the plexus of lymphatics about the larger venous trunk; a small amount of lymphoid tissue is found (Fig. 3).

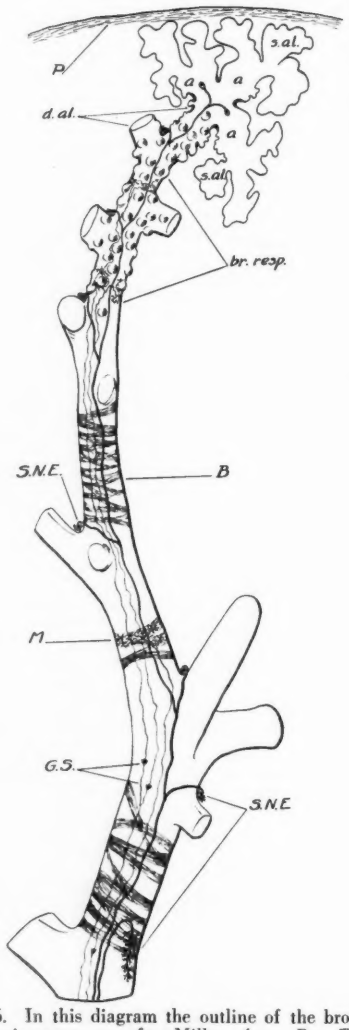

Fig. 6. In this diagram the outline of the bronchioli and the air spaces are after Miller, *Amer. Rev. Tuberc.*, 1921, V, 689, and the nerves are after Larsell, *Jour. Comp. Neurol.*, 1922, XXXV, 97, and *Northwest Medicine*, Sept., 1923. *P.*, pleura; *s. al.*, sacculi alveolares; *a.*, atria; *d. al.*, ductuli alveolares; *br. resp.*, bronchioli respiratorii; *B.*, bronchiolus. *G. S.*, ganglion cells; *M.*, post-ganglionic fiber ending in a smooth muscle spindle; *S. N. E.*, afferent nerve ending; sensory nerve endings (?).

At Point 3, the vein arising from the place where a bronchus or a bronchiolus divides, joins a large venous trunk; the lymphatics accompanying this vein join the

lymphatic plexus about the large venous trunk; there is a larger amount of lymphoid tissue than is present at Point 2 (Fig. 4).

At Point 4, the only veins found within the primary lobule take their origin. In young and middle-aged individuals there is a small amount of lymphoid tissue, which becomes more pronounced in old age. The last of the lymphatics which accompany the subdivisions of the bronchial tree pass, on the one hand, to the veins which take their origin at this point, on the other hand, they form an anastomosis with the lymphatics which accompany the pulmonary artery. The smooth muscle in the walls of the ductulus alveolaris forms a sphincter about the openings leading into the atria (Fig. 5); smooth muscle ceases to be present; sensory nerve endings are found.

At Point 5, which may be wherever a bronchus or a bronchiolus divides, anastomoses between the lymphatic plexus in the given division of the bronchial tree and the plexus about the pulmonary artery take place; one or more lymphatics pass to the pulmonary veins which have their origin at this point; lymphoid tissue in varying amount is present, and where the first two or three branches leave the main stem bronchus, lymph nodes are found; sensory nerve endings are present (Fig. 6); cartilage, when present, is found.

In addition to these five points, attention should be paid to the change in the vascular supply of the final divisions of the bronchial tree *from* the bronchial artery, *to* the pulmonary artery. With the appearance of alveoli along the bronchioli, the bronchial artery as a nutrient vessel to the bronchial tree disappears, and the network of capillaries in which it terminates joins the network of capillaries derived from the pulmonary artery, and the bronchioli respiratorii, the ductuli alveolares, and the air spaces connected with them, receive their blood from the pulmonary artery. This transitional zone is the one in which tubercles are most prone to develop. Possibly a retardation of the circulatory force at this point may be a determining factor.

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Lumbosacral dislocation.—The relative space and variation in angle between the lower border of the fifth lumbar and upper border of the sacrum is fairly constant, while the variation in the inclination of the fifth lumbar vertebra and the angle between the anterior border of the sacrum varies greatly in normal individuals. At birth the angle is considerably less than that observed roentgenographically in the average adult. The diagnosis of lumbosacral dislocation should never be made from an antero-posterior exposure alone. Lateral exposure may show an inclination of the fifth lumbar, combined with a practically horizontal first sacral segment, which produces a marked foreshortening in the antero-posterior exposure.

J. D. CAMP, M.D.

Lateral Roentgenography of the Lumbosacral Region. Leon T. LeWald. Am. Jour. Roentgenol. and Rad. Ther., Oct., 1924, p. 362.

THE X-RAY SHADOWS OF SECONDARY INFECTION IN LUNG TUBERCULOSIS

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ON account of the physical conditions in the lungs, their radiologic densities are susceptible of finer analysis than are those of any other part of the body. Further, nothing in this field is of more interest and value than the differentiation, whenever possible, of lesions caused by tuberculosis from those produced by other infections.

It is well recognized that there are no pathognomonic physical signs of lung tuberculosis; however, radiologists believe that their particular contribution to the physical examination of the chest, when skillfully interpreted, will more accurately indicate the nature of a lesion, as well as its location and extent, than will any other part of that examination. Since the criteria which the clinician accepts in physical findings as suggesting tuberculosis and those which point the radiologist to this conclusion are based on the same fundamental anatomy and pathology, there should be no antagonism. The radiologist must always remember that his contribution to the physical examination is supplementary, even on those occasions when the supplement, like a woman's postscript, furnishes the real meat of the examination.

The fundamental investigations of Miller and Dunham, many years ago, regarding the architectural structure of the lung, the method of invasion by tubercle bacilli and the pathology produced pointed the way to our subsequent observations that tuberculous infection and infection by other bacterial invaders produce different kinds of shadows in the lung field. If we will base our interpretations upon the fundamental investigations of Miller and Dunham, to which there have been no material additions, we will be in position to differentiate etiological factors with a reasonable degree of certainty. It is our belief that wherever we have departed from the fundamentals mentioned and interpreted shadows as tuberculosis, without proper regard for the underlying pathology which must produce such densities, we have been out on the thin ice of conjecture and have too often been wrong in our conclusions.

We know that tuberculosis invades lung tissue through the lymph channels; therefore, that the infection first surrounds the lobules, because the lymphatic vessels enclose each anatomical lung unit very much as a fishnet holds its contents. The smallest visible tuberculous lesion, therefore, is the dim outline of a secondary lobule, with its congested lymphatics and beginning granulomatous consolidation. Such a lesion is essentially parenchymatous, and since the lung parenchyma fills all the space between the hilus and the pleura, the tuberculous density may occur anywhere in this lung field. The lesion has a definite relation to the bronchial tree, and this relation can be traced by the striation densities which mark the blood vessels accompanying the bronchi. In instantaneous films, with the very finest detail, we can make out the extremely delicate fishnet-like shadows surrounding the involved lobule, within which is an area of increased radiopacity. On the usual film, there is only a blurring or haziness, more or less sharply delimited from the surrounding tissue, being roughly triangular at the lung periphery, though with varying shapes when located more deeply within the lung. Usually when a patient comes for radiography, the tuberculosis is extensive; however, if not complicated by mixed infection, even a conglomerate shadow will show a simple multiplication of the characteristic lobular density. The loss of this type of shadow, or the ob-

scuring of it by atypical densities with bizarre formation is, in itself, good evidence of a complicating secondary infection.

In addition to its definite character, the tuberculous density is, for all practical purposes, an upper lobe shadow. Without discussing the reasons for this, it is a fairly safe rule that tuberculosis does not invade the basal regions until the local or general resistance has been lowered by some accompanying infection.

Therefore, in differentiating lung shadows, with reference to their etiology, we have two fairly safe guides: one is the location of the density; the other is its structural peculiarity. Pyogenic infections of the lung are mucogenous, as a rule, and invade along the bronchial mucosa, spreading from within the structural units, so that when developed to the stage of visibility, they are relatively more radiopaque than are tuberculous shadows. Of course, after a consolidation is well established, the shadow will be the same whether the invasion is from the periphery through the lymphatics or from the center, as in pyogenic infections. However, it is very seldom that we find isolated tuberculous consolidations, without adjoining lesions presenting the typical characteristics of early tuberculosis. Tuberculous consolidations, when uncomplicated, usually spread by continuity and coalesce, while those of other infections are more likely to be discrete, even when quite numerous. Miliary tuberculosis, of course, is an exception.

When pyogenic or influenzal infections occur in the tuberculous lung, their shadows do not differ materially from similar densities in the non-tuberculous lung. In the hitherto normal lung, such infections are prone to involve the basal or hilus regions, so that accentuation of the hilus densities, or discrete densities in the hilus region, or discrete or irregular densities in the base, should be interpreted as probably non-tuberculous. When the same type of shadow occurs in a non-tuberculous lung, they should again be interpreted as probably non-tuberculous. If we have a cavity in the upper lobe of one lung and it becomes secondarily infected, we will soon find in the parenchymatous tissue surrounding this cavity shadows which, if found elsewhere in the lung, we would undoubtedly regard as the densities of non-tuberculous lesions. It is just as reasonable to interpret them as lesions produced by secondary invaders of the cavity as it is to regard them as tuberculous densities. In many cases an analytical interpretation is not possible, because a tuberculous caseating area soon becomes secondarily infected, and areas of secondary infection frequently become tuberculous, so that the shadows become so interwoven that the best we can say is that the method of extension and possibly the character of isolated densities suggest the influence of secondary infection complicating the tuberculosis.

Many of these densities which we attribute to non-tuberculous infection resolve and disappear. It may be said here that the only controversial point in this paper is whether a true tuberculous lesion, after developing to the stage of visibility on the X-ray film, will entirely resolve, leaving no trace of its shadow. It is our belief that a tuberculous area, or any other granuloma, will not entirely heal by resolution, but there will always be some degree of cicatrization with resulting fibrous tissue visible on the radiograph. Conversely, that densities which do entirely resolve and disappear were not granulomata, but were simpler and less organized consolidations. We do not think that Gardner's report of the resolution of tuberculous lesions in experimental animals covers the point, so far as the radiopaque densities in human lung tuberculosis are concerned. The toxic reaction which occurs around all recent tuberculous foci and which is shown on the X-ray film as a nebulous density extending beyond the central area of greater opacity, will subside and the tuberculous shadow become correspondingly smaller, but there will always be some trace of it, if the cellular

components of the granuloma are once organized.

In studying lung densities, we regard as presumptively non-tuberculous the following:

(1) Any abnormal shadows confined to the basal region alone, whether due to an accentuation of the bronchial tree ramifications, or whether they are entirely isolated; whether discrete or conglomerate; whether recent or old, unless they present the typical characteristics of tuberculous infection which we do not recall ever having seen in the lung base. We realize that this interpretation will occasionally be in error, but not very often.

(2) Markedly accentuated hilus densities, or isolated densities near the hilus but lying apart from it. In the adult, the source of error here is not great, if we take care to differentiate the old linear striation and beading of healed tuberculosis from recently formed densities. In the infant and child, however, it is practically impossible to differentiate the shadows of hilus tuberculosis, slowly spreading along the main lymph channels, from the shadows of a low-grade bronchopneumonia such as we find following whooping cough or measles. The chief differential point in such cases is the observation of resolution and disappearance of well established densities, which we regard as establishing their non-tuberculous nature for all practical purposes.

(3) Discrete, rounded or irregular densities lying apart from the shadows of an evidently tuberculous area and without any visible relation to the bronchial tree involved in the manifest tuberculosis. Here the chances of error of course are great and the conclusions, as previously stated, should only be general, as it may be impossible to pick out any given shadow as the density of secondary infection. However, the general character of the density and the method of extension are often very suggestive.

The practical value of differentiating, whenever possible, the shadows of tuberculosis from those of a complicating infection should be obvious. For example, a rapidly advancing unilateral lesion, if tuberculous, probably would require different management from one which is due to a secondary infection. Or a mixed infection spreading out from a lung cavity or an abscess distributing pyogenic infection through a tuberculous lung, would require different treatment from that demanded by a pure tuberculosis.

Aside from these factors of practical value to the clinician, it is expected of the radiologist that he will go as far as possible in the study of and interpretation of types of pathology examined by him, and nowhere in the body can this analysis of pathology be carried so far as in the study of lung shadows.

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Vital staining of tumor cells.—Mitochondria are demonstrable in rapidly growing transplantable rat and mouse tumors. Sublethal and lethal X-ray doses given percutaneously have produced few significant changes within the first forty-eight hours after exposure. A perceptible diminution in mitochondria is frequently exhibited forty-eight hours after radiation. Occasionally an edema of the cells is observed. Neutral red vacuoles are not present in the normal vigorous tumor cells, but tend to accumulate during the degenerative phase.

SOLOMON FINEMAN, M.D.

Vital Staining of Tumor Cells After X-ray. R. E. Prigosen. Jour. Cancer Research, July, 1924, p. 305.

APPLIED PATHOLOGY OF PULMONARY TUBERCULOSIS[1]

By KENNON DUNHAM, M.D., and JOHN H. SKAVLEM, M.D., CINCINNATI, O.

OUR greatest knowledge of the pathogenesis and pathology of pulmonary tuberculosis has come from two sources: postmortem studies and animal experimentation.

The most instructive study has been the artificial production of the disease in the animal. In our human patients we have been able to study the actual changes wrought in the lungs by the tubercle bacillus only by the indirect signs elicited by the clinical examination of the patient. We have realized our shortcomings and errors in translating physical signs into pathological changes within the lungs. Therefore we have seized upon animal experimentation to teach us more, since here we can control our material and make direct observations of the lungs at will.

We have learned and are learning much from the observation of animals; it behooves us as well to view each human patient as a source of scientific knowledge. Armed with the knowledge gained from experimental studies, the pathologist lays bare the dead lungs on the autopsy table and tells us what has happened. Armed with the same knowledge it is possible for the trained observer to lay bare the living lungs on the X-ray plate and tell us what has happened, what is happening, and what probably will happen. The use of the X-ray plate in the diagnosis of pulmonary tuberculosis is firmly established. Its value does not stop there, for it gives us the means of studying the disease as a scientific problem in its own unfortunate living host. Anatomy was taught us by dissection of the dead; now in our modern progressive anatomic laboratories the X-ray presents to the student that study in the living. Lung pathology was also taught to us by dissection of the dead, but now the progressive investigator is viewing his postmortem findings largely as confirmation of his observations and predictions made from an X-ray plate. Such mental dissections of lung lesions from the X-ray plate offer much for our further studies of the disease.

In the experimental production of pulmonary tuberculosis a definite limitation must be recognized. The lesions as we recognize them in the infant can readily be produced in the animal, but the adult type of lesions with cavity formations is rarely, if ever, produced by any of the usual methods of animal inoculation. To produce cavernous pulmonary tuberculosis, whether by inhalation or by feeding, it is necessary to adopt a scheme of introduction of the bacilli whereby they are made to gain entrance into the lymph passages in relatively small doses. When live tubercle bacilli are first introduced into an animal, even if the lung is the primary site of inoculation, a lesion is produced which has little resemblance to the lesion of adult pulmonary tuberculosis. With the first or primary injection of live tubercle bacilli in the animal there will immediately result a relatively slight lesion at the point of inoculation, but the nearest regional lymph nodes will enlarge and show marked reaction. No exudation will occur at the point of inoculation unless the dosage be large. The lesion formed at the point of inoculation will differ according to the dosage administered. With small dosage there will be slow development of the lesion by proliferation and increase of cells of the fixed type, or the so-called epitheloid cells. With large dosage there will be produced an immediate outpouring of polymorphonuclear cells, leukocytes which rapidly disappear, and then the proliferation of fixed cells goes on in an orderly slow manner. When the animal is again inoculated with live tubercle bacilli we observe "Koch's phenomena."

[1]Read by title at Annual Meeting of Radiological Society of North America, Kansas City, December, 1924.

There is an active reaction with exudation and necrosis at the site of the second inoculation. This lesion does not progress in an orderly sluggish manner; it tends to heal and no tuberculosis of the regional lymph nodes is produced. So, too, if live tubercle bacilli are injected into the pleural cavity of an animal which has received no previous inoculations, no fluid will be produced. But if the inoculation is made into the pleural cavity of an animal suffering with tuberculosis, a clear fluid will invariably result. An understanding of these simple experimental observations is necessary to our comprehension of the pathogenesis of tuberculosis in the human.

The pathology of pulmonary tuberculosis presents the greatest diversity and multiplicity of lesions. In interpreting our X-ray plates many investigators are too apt to think only of the tubercle as the pathological entity of tuberculosis. We must remember that tuberculosis can mean anything from a small nodule made up microscopically of giant cell, caseation, epithelioid and lymphoid cells, to a whole lung which has become solid, or a lobe entirely honey-combed by cavities. The tissue changes of pulmonary tuberculosis involve exudation, proliferation, caseation, degeneration, necrosis, cavitation, liquefaction and repair.

With the implantation of the tubercle bacillus in the tissues of the body the pathological changes which immediately result vary with every individual. But most striking in the difference of reactions are the changes wrought in the adult and in the child. At the very beginning of our researches the great differences between the X-ray chest plates of the tuberculous child and the tuberculous adult were observed and described. It was a great satisfaction when, in 1917, and again in 1924, Opie discussed these differences from the viewpoint of pathology and postmortem findings.

Pulmonary tuberculosis of early childhood does not affect one part of the lung oftener than another. In the first year of life there is almost no tendency for the lesion to heal but progressive caseation occurs and miliary tuberculosis is a frequent termination. The lymph nodes at the hilum are invariably markedly involved and usually are the earliest and chief centers of disease. Jordan, in examining the chests of children roentgenographically, found these earliest lesions at the hilum. By this pathological research he proved that the nodes were much more extensively involved than the parenchyma of the lungs and that there is a peribronchial inflammation. Ghon recognized pathologically all that Jordan had seen on the X-ray plate and conclusively showed that tuberculosis of the tracheo-bronchial lymph nodes does not occur as the primary focus but is so frequently associated with a lesion in the lung substance that we may assume the invariable presence of the parenchymal focus. Our X-ray observation and pathological studies confirm Ghon's conclusions. The primary intra-pulmonary lesion plus that produced in the hilum nodes has been termed the "primary complex" by Ranke. Ziegler recognized exactly the primary seat of the tuberculous focus and described it to be where we know lymph tissues normally exist, but he failed to emphasize the importance of the lymphoid tissue.

Hilum tuberculosis in children with the old Ghon in the parenchyma has all the characteristics of first infection. Following the establishment of this primary complex the disease, especially in the young, may become generalized by the blood and terminate in meningitis. With increasing age, however, there is a marked tendency for this primary stage to heal. Various stages in the process of healing may be seen in the lungs of children who die from other causes. These lesions may be recognized as (1) small caseous nodules encapsulated by fibrous tissue; (2) caseation encapsulated by calcium; (3) calcification with fibrosis. Opie has published some most interesting findings in postmortem studies of St. Louis children.

Examination of the lung on postmortem may disclose only a few calcified nodules, whereas X-ray plates of the chest or lungs clearly show their distribution and number. The routine followed in our studies of correlation of X-ray densities and tuberculous pathological changes in the lung was to remove the lungs from the body, inflate them to their normal size and make stereoscopic X-ray plates. From the plates we found we could invariably diagnose and localize such healed areas of calcification, caseation and fibrosis as to enable us to cut down on them with ease. Just as we localized them with accuracy in the lungs removed from the body, so it is possible to recognize them and place them in the chest in relation to the trunks.

The early puerile lesion as seen upon an X-ray plate consists of a small circumscribed area of density connected to the hilum by a heavy trunk. Such parenchymal foci are usually seen within the mid-lung zone. They may be distributed anywhere throughout all lobes and only exceptionally are they found at the apices. There is no special susceptibility at the apices for the primary childhood infection of tuberculosis. The hilum shadows are heavy, showing densities suggestive of calcification, caseation or fibrosis. Sometimes enlarged pulmonary or bronchial nodes may be seen.

The clinical significance of such findings on the X-ray plate of a child is a question of such import as to have caused the formation of a special investigating committee by the National Tuberculosis Association to prosecute such research as would tend to standardize our interpretations. We cannot decide from an X-ray plate alone when these densities are of clinical significance. Thickened trunks and enlarged hilum shadows on an X-ray plate may be caused by various other childhood diseases, such as measles, whooping cough or mumps. They can never be considered as being the result of tuberculosis unless calcification or caseation are definitely shown to be present. Even then, these markings cannot be interpreted as being evidence of active disease unless a definite parenchymal "fan" is visible. But there is one peculiar density seen in the hilum which has clinical significance. This we term a caseo-calcareous node. Upon the X-ray plate it has the density of calcium. It is usually quite large and can be seen to be made up of many small flakes of calcium rather than one stone. Upon microscopic section we find that such lesions consist of a soft caseous center containing calcium and larger hard flakes of calcium around the periphery. Such lesions we have never found to be healed on postmortem studies and they should always be considered as potential foci of infection.

Adult apical tuberculosis resembles in all respects the reaction to the second infection in experimental animals. It is the reaction of an infection in a sensitized animal. The usual case of active pulmonary tuberculosis in the adult is the result of repeated infections. The immunity and resistance gained by the infections of childhood alter the course and picture of the disease in later life. The focal lesions of early life which have healed are beneficial, but they do not always effectively protect. The patient has relative immunity, but a diminution of resistance is brought about by intercurrent disease, fatigue, malnutrition and various other factors. Immunity diminishes when recovery occurs and disappears after the lesion is completely healed, but is increased by re-infection, spread or metastasis of the active disease. Re-infection may occur after long periods of quiescence. This undoubtedly happens in human beings, when immunity is comparatively low. So, too, in the adult human infection we find the prompt response of local reaction at the point of inoculation, and the constitutional changes so characteristic of the reaction in the sensitized animal.

Before a child is ten years of age he is usually sensitized and has acquired a degree of immunity. Infection after this age incites the picture of adult tuberculosis with

apical localization, tendency to chronicity with fibrosis, cavity formation and noticeable absence of associated tuberculosis in the regional lymph nodes. The tubercle bacillus has gained entrance by inhalation, penetrated the epithelial lining of the lung, gained entrance into the tissues, where it has been gathered up by the lymphatics and then has incited a local reaction in an allergic soil. The first reaction to the implantation of the tubercle bacillus in an allergic soil is an exudate at the point of inoculation. This phenomenon is the most striking difference between the adult and puerile types of tuberculosis. Peculiarly, the exudation takes place immediately under the pleura. Our X-ray observations show invariably that the adult lesion starts immediately out under the pleura. This phenomenon is vitally important because it explains why we find physical signs early in adult tuberculosis and answers the question why the X-ray plate lends itself so readily to the study of the pathological changes in this type of the disease. We do not attempt to answer why the exudation appears immediately under the pleura. Certainly the lymph flow must play a great part.

As before stated, an exudate is the first reaction to the implantation of tubercle bacilli in the tissues of a sensitized individual. If a massive dose has gained entrance at any certain point, the exudation is of the polymorphonuclear type, due undoubtedly to the reaction of the tissue to a foreign protein. But this polymorphonuclear exudate disappears in about forty-eight hours, to be replaced by a mononuclear exudate and proliferation of fixed tissue cells. From these elements the characteristic microscopic picture of tubercle formation with giant cells, epitheloid cells and lymphocytes is produced.

From this point the pathology progresses either to the reparative changes of fibrosis and calcification or to the destructive changes of caseation, ulceration and cavitation. When an adult is in possession of the ordinary amount of allergy and resistance any lesion of pulmonary tuberculosis always tends toward healing. It is also true that the lesions of an adult type of the disease are the results of repeated infections, either from within or without. For instance, the first lesion within the lung of an individual case, let us say, is in the right apex. This particular lesion has gone through the pathological changes of exudation, tubercle formation and is now present only as an old fibrotic scar. But while this oldest lesion has been progressing to repair and healing, let us say, a newer lesion has developed at some other point lower down in the lung or in the opposite apex. This newer lesion may be the result of spread from the original lesion or a new infection from without. This second lesion, we will say, is in the state of exudation. Drawing the picture still farther, we may have developed an area of caseous bronchopneumonia in one of the lower lobes. This lesion is the result of aspiration of infectious material from an apical lesion. Now, in this problematical, yet typical case, there are three distinct lung lesions, all due to tuberculosis and each one in a different state of pathological change. There are present exudation, caseation and fibrosis.

We must turn again to anatomy to explain these lesions as we find them on physical examination, on the X-ray plate, and in postmortem studies. Septa are prolongations of the connective tissue from the pleura down into the lung. These connective tissue septa, rich in lymphatics, act as excellent barriers to the spread by continuity of any lung pathology characterized by exudation. Inflammatory exudation starting within any one of the small compartments, anatomically known as "secondary lobules," is definitely limited by these barriers. Spread through such a septum will not take place until cavitation occurs. The localization and restriction of the pathological changes by these septa account for our localized râles on physical examination and also explain the "fan" on an X-ray plate.

Let me state, however, that these fans may be present in any lung disease producing exudation. The cellular elements of an acute lobular pneumonia, apical catarrh or an infarct are all held in check by the septa and can consequently give localized signs and a "fan." The differentiation of these lesions can be made by an understanding of the progressive pathology of tuberculosis just described and the ability to recognize it upon an X-ray plate.

From extensive research it has been established that the densities caused by the pathological changes of pulmonary tuberculosis as shown on an X-ray plate vary in their quality and degree of density, progressing from the least dense to the heaviest, as follows: (1) serous exudate, (2) cellular exudate, (3) fibrosis, (4) caseation, (5) calcification. Given, then, the problematic case cited above or any case of adult tuberculosis showing two or more lesions, the X-ray picture will be characterized by the densities of different qualities. A thorough study of X-ray chest plates with this understanding will enable you to read the changes in terms of actual pathology. The localized, cone-shaped lesions, walled in by the septa, will never be seen in postmortem studies if the pathologist's usual sweeping cut from apex to base is made. But if you will carefully dissect out along the bronchi, you will easily lay bare these lesions immediately under the pleura. So, too, if you read your X-ray chest plates with no respect to trunks you will never see the fan. But, again, if you will follow out along the different trunks, the lesions present will not appear as one continuous mass, but you will be able to mentally dissect the changes and translate them into their actual progressive pathology.

After the apical lesion, the most common lesion of adult pulmonary tuberculosis is caseous bronchopneumonia. It is invariably associated with old apical lesions, usually containing cavities. It invades the lower and middle lobes and lower part of the upper lobes, and not infrequently the apex opposite to an old lesion. It is in all probability caused by aspiration of sputum droplets containing large numbers of the bacilli and so can be described as the reaction of massive infection in a highly allergic soil. Upon gross section of the lung and microscopic studies it is recognized as a diffuse heavy mottling, frequently seen scattered along the main trunks, suggesting "raisins upon a stem." It may become confluent and produce pseudo-lobar caseous pneumonia.

Lobar or massive caseous pneumonia occurs in both the adult and child. In the adult type, old apical lesions are always present; in the adult type the old apical lesion may not give enough symptoms to drive the patient to a physician or may be overlooked in a physical examination. Thus a definite tuberculous lesion may have existed for some time and may be recognized only when the massive lesion has progressed to cavitation and death is close, hence the name "hasty consumption." Allergy, as shown by Krause, teaches us that "if a man falls acutely ill with tuberculosis it means that there has been rapid, fresh extension or metastasis of infection from pre-existing foci, known or unknown." In X-ray studies the old lung foci are found and the progress of the new massive lesion followed.

Acute miliary tuberculosis deserves special consideration. We believe it is the result of lack of or loss of immunity. Thus we find it associated in the adult with definite old healed lesions, as revealed by the X-ray plates, or frequently there is no evidence of primary focal infection. In children, the old focus may not be evident, or a Ghon may be occasionally seen, or the primary focus found in another part of the body. Many cases of healed miliary tuberculosis are being found by our more general use of the X-ray chest studies. This diagnosis is justified only when the subject gives no history of work in a dusty trade. Lungs of anthracite miners most nearly simulate miliary tuberculosis. The X-ray picture is

that of fine sharp discrete studdings, more or less evenly distributed throughout all lobes.

The predominance and significance of caseous pleurisy has been greatly emphasized by X-ray studies. The X-ray picture is that of empyema associated with caseous bronchopneumonia without old apical lesions. At U. S. General Hospital No. 19 we had opportunity to study 17 cases by X-ray plates and careful postmortems. The pleura showed massive thickening with solid caseation, involving chiefly the parietal pleura. The lesions within the lungs were comparatively slight. Old apical lesions were seldom, if ever, present. In some cases the solid caseation of the pleura measured 5 cm. in thickness. The end was invariably, rapidly fatal, although the patient neither felt nor looked "sick." Literature reveals meager mention of the condition. Letulle gives a short, concise, microscopic description, with some excellent illustrations. German investigators during the war reported a few cases among the Arabian troops in Turkey. To us, caseous pleurisy represents the reaction to a massive infection in an individual devoid of resistance. It is comparable to the other massive lesions found in the lymph nodes or represented by lobar caseous pneumonia as found in the aborigines and other primitive tribes. This has been emphasized by Bushnell. Of our 17 cases studied, 14 were found in young adult negroes coming from the rural districts. The X-ray studies in each case showed the massive changes and absence of old apical lesions. The type of case and progress of the disease was followed in the living by the X-ray. Our deductions were proven by autopsy.

CONCLUSIONS

Hilum and peribronchial tuberculosis are terms born of a false conception of the pathogenesis of pulmonary tuberculosis. It is conceded that the tubercle bacillus enters the system in one of many possible ways, such as passing through the large bronchial walls to the bronchial nodes, or through the intestinal tract without involving the mesenteric nodes and in some mysterious way reaching the bronchial nodes. This is supposed to occur usually during childhood; the infection then dies dormant in the bronchial nodes for many years and sometimes after puberty immunity or resistance is lost and the infection passes backward through lymph channels to the parenchyma of the lung by way of the peribronchial or perivascular lymphatics. Thus we have, first, hilum tuberculosis and then peribronchial tuberculosis and, finally, parenchymal tuberculosis. This conception, which is false, is contrary to our knowledge of anatomy, pathology and our X-ray studies and also disagrees with the modern conception of pathogenesis of pulmonary tuberculosis which has been so ably described by Opie and Krause.

In contrast to this, we conceive that the adult and puerile types of pulmonary tuberculosis, which are so clearly differentiated by the X-ray chest plates, have a firm foundation in anatomy, pathology and allergy. The infection enters the lung by the air passages or the blood stream, is carried from either to the lymphoid tissues, which are directly connected with the lymph vessels. In the child, we have very little reaction except near the point of inoculation and this is mostly interstitial, but a great reaction of the regional lymph nodes. In the adult, we have comparatively little reaction of the lymph nodes but massive reaction around the infection, with extensive exudate which floods a definite part of the lung. Thus, in the child which is not sensitized, the reaction to the tubercle bacillus is little like an inflammatory reaction, while in the adult, the reaction is a severe inflammatory reaction, and is seen upon the X-ray plate as a density under the pleura. Pulmonary tuberculosis is a disease of successive infections, therefore of differing ages, which causes the fans to have differing densities.

These differing densities are easily recognized upon the X-ray plate.

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Surgery in pulmonary tuberculosis.—In reviewing a series of operative deaths, it would appear to us that in one case the fatal result could not have been foreseen. In three cases it probably could have been avoided by a two-stage instead of a one-stage operation. In one case it was probably a poor selection until the patient had been brought into a better general condition. In one case death, resulting from the unusual accident of massive collapse of the opposite lung, might conceivably have been prevented by a two- instead of one-stage operation. We believe, therefore, that from our experience it may be possible for us to report a considerably lower percentage of mortality in the future.

It has been definitely demonstrated that thoracoplastic collapse of the lung is of very real value in the treatment of certain types of tuberculosis. It is very closely associated and bound up with the problem of treatment by artificial pneumothorax. At the present time approximately 50 per cent of carefully selected cases may be returned to a satisfactory degree of health. The present mortality of approximately 25 per cent may probably be reduced in the future by better operative technic and more skillful selection of cases. We now believe that only in the rarest exceptions should operation be performed in less than two stages. The proper selection of cases is the most important single problem to be considered. Cases so operated on still have their tuberculosis and must undergo prolonged after-treatment along approved lines, especially rest. The success in treatment of these cases can be obtained only by the closest co-operation between physician and surgeon. The judicious use of this operation will not only restore many hopeless invalids to economic independence but is a public health measure of importance, by rendering sputum-free a class of cases which are often a real menace to their associates.

W. W. Wasson, M.D.

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THE RELATIONSHIP OF THE RADIOLOGICAL DIAGNOSIS OF TUBERCULOSIS OF THE LUNGS TO THE CLINICAL DIAGNOSIS[1]

By JAMES J. WARING, M.D., Denver, Colorado

IT IS my purpose in this paper to discuss first, briefly, some technical difficulties encountered by the roentgenologist in making a roentgenogram of the lungs, considering particularly the interference of the bony thorax with lung detail. Next I will discuss the importance of air content for the portrayal of both normal and pathological pulmonary structures. This will lead to a more extensive discussion of the relation of the roentgenographic changes to the underlying pathologic condition and finally to a summary comparison of the value of certain clinical data with the X-ray findings.

Twenty years ago an X-ray picture of the lungs was commonly made as follows: The current was turned on for ten seconds while the patient held his breath; after being allowed to breathe a few times the current was again turned on for a few seconds while the breath was again held, this being repeated several times. To-day the most experienced men are making roentgenograms of the lungs in less than one-tenth second. This speeding up of the making of a picture has worked wonders in securing clearness of detail; it has surmounted such difficulties (1) as vibrations of the whole body due to the throb of the heart beat, movements of lung structures due to periodic compression and relaxation with cardiac systole and diastole, and the rocking movement of heart and aorta described by Wasson. It has also taken care of the little movements due to carelessness or lack of co-operation from any cause. In passing, let it be noted that many of the patients subjected to chest roentgenography are far or moderately advanced consumptives with markedly diminished vital capacity, and therefore find it very difficult, in certain cases impossible, to hold the breath. Unfortunately, speed of exposure has not obviated certain other difficulties. H. A. Bray (2) calls our attention to the fact that the mediastinum is short and thick on costal inspiration and long and narrow on diaphragmatic inspiration. Since the hila move with the diaphragm, in addition to showing appreciable changes in both outline and density the hilar shadows may move as much as two interspaces lower with diaphragmatic than with costal inspiration. When films are made both during suspended diaphragmatic and suspended costal inspiration, Louisa T. Black (3) thinks about 10 per cent of cases will show additional pathologic findings.

It is not intended to make more than a passing reference to some of the technical difficulties of securing a good lung picture, among which should be mentioned tube stability, focal distance and chest thickness (4), but I should like to discuss more at length the perhaps unappreciated extent to which the shadow of the bony thorax interferes with good definition.

INTERFERENCE OF BONY THORAX

The whole lung field (Fig. 1) of the chest roentgenogram included within the outlines of the ribs and the curves of the diaphragm, may be divided into three parts,—the right lung field, the left lung field and the interposed central mediastinal and cardiac shadow. In the adult, the area of this central shadow is 27.57 per cent of the whole area, decreasing from 44.75 per cent in infancy. In other words, in the infant the central shadow occupies nearly one-half the area of the roentgenogram; in the adult it occupies only a little more than one-quarter. From roentgenograms at various ages made by Wasson, I have calculated (Table I) the relative areas of each lung: (1) Overlaid by the shadows of single ribs, (2) Overlaid by the shadows of two ribs crossing, and (3) Not overlaid by rib shadow. The calcula-

[1]Read before the Radiological Society of North America, at Kansas City, December, 1924.

tions are for single instances only and were made as follows: Careful tracings of selected films were made on regular tracing paper, the various areas cut out with scissors and weighed on a chemical balance.

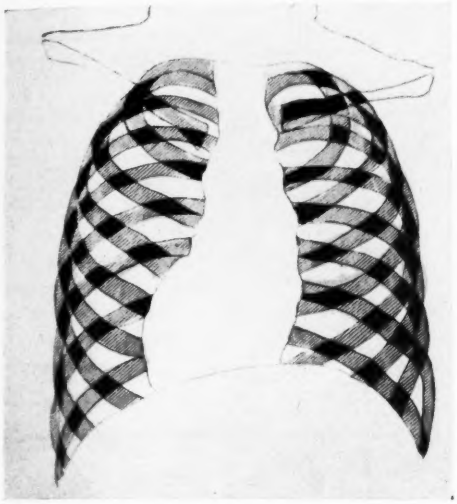

Fig. 1. Tracing of film of adult showing (1) free lung area, unshaded; (2) area obscured by shadow of one rib, lightly shaded; (3) area obscured by shadow of two ribs crossing, heavily shaded.

Then, since comparative sizes only were desired, it was considered that the surface area of any part of the field was to the surface area of the whole as the weight of that part was to the weight of the whole. Weighing tests showed that different portions of the paper itself were remarkably uniform in weight. From the study of these figures it is evident that in the adult, on the average, less than one-third of the lung field is free from the interference of the shadow of rib or clavicle. I appreciate perfectly that under certain conditions the screening influence of the ribs may strengthen rather than diminish detail, but in such circumstances the shadows of minimal tuberculous lesions falling on free lung areas will be lost entirely. The ideal picture should bring out the uttermost detail on these free lung areas. A lateral tube shift reduces interference by the central cardiac and mediastinal shadow, but has little effect upon the rib shadows; on

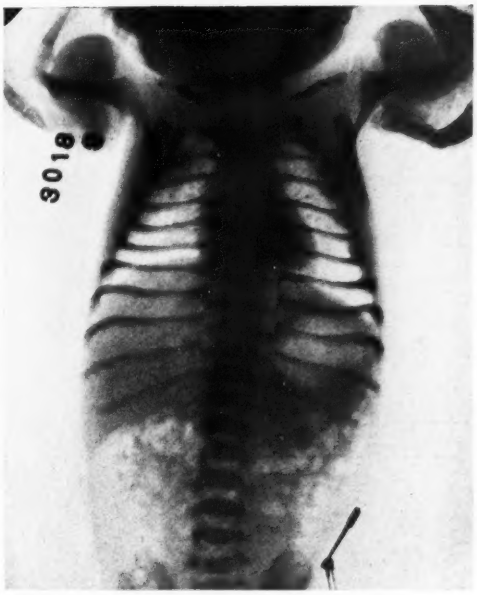

Fig. 2. Roentgenogram of chest of infant aged 24 hours. (By W. W. Wasson.)

the other hand, a head-foot tube shift reduces interference from the foreground screen, formed by the posterior arms of the ribs, and not at all the interference by the background screen, formed by the anterior arms of the ribs.

Certain other points about the infant thorax are worth while noting. In the adult the U-shaped ribs leave the vertebral column with a downward slope and are twisted on their axes, so that their combined shadow on the film, at least the upper ten, resembles that of a chain of interlocking U's, with the curve lateral and the open end closed by the median bar of the mediastinal shadow. At birth (Fig. 2) and for a few months after, the ribs are shaped like fishhooks, that is, with a long posterior and a short anterior arm, which increases rapidly in length with the months. The costal cartilages are relatively long and cast little or no shadow. In many instances the shadows of the short anterior arms of the upper four to six ribs curve upward, the shadow of the short arm of the middle one to three ribs overlaps, more or less exactly for a short

AGE	Heart Shadow % of Total	Right Side % of Total	1 Rib % of R. Side	2 Ribs % of R. Side	Free Lung % of R. Side	Left Side % of Total	1 Rib % of L. Side	2 Ribs % of L. Side	Free Lung % of L. Side
Twenty-four-hour baby	44.75	27.59	51.22	7.31	43.90	24.75	44.44	5.55	50.00
Two-month child	45.67	30.59	52.00	4.00	44.44	23.47	55.26	5.26	34.21
Six-month child	42.92	35.60	45.20	2.74	52.05	20.00	65.87	4.87	29.26
Two-year-ten-month child	36.90	31.19	55.00	16.72	28.24	29.52	52.42	16.12	31.54
Six-year-six-month child	33.39	34.69	42.52	28.03	25.23	31.94	47.20	29.66	21.78
Nine-year child	32.42	36.25	52.78	16.72	30.49	31.22	50.76	20.99	28.62
Adult	27.57	35.54	46.91	22.45	32.52	30.16	49.90	19.09	29.55

Table 1. Table showing relative size of lung shadows at different ages.

distance, the shadow of the long arm, and the corresponding shadows of the next four or five ribs curve downward. At six to eight months the shadows of the short arms on the left reach the shadow of the left border of the heart and on the right the corresponding shadows reach one-third to one-half the distance to the right border of the heart. At twelve months, on the left the shadows of the short arms overlap the shadow of the left border of the heart and on the right the corresponding shadows just reach the shadow of the right border of the heart. At fourteen to sixteen months, on the right the shadow of the right border is overlapped by the shadows of the short arms. These ages are only approximate, as variations are very great. If we divide the lung field into three zones (Fig. 3 *A*) according to the plan of Dunham, Baetjer and Pancoast (5), we then find the outer zone considerably obscured by rib shadow. Figure 3 *B* illustrates the relation to the chest roentgenogram of those areas to which at physical examination the clinician devotes particular attention. The two upper markers indicate Chauvet's "zone of alarm" and correspond on the surface of the chest to the places where the bell of the stethoscope rests in listening to the apices of the upper lobes; the two lower markers are placed on the back opposite the fifth dorsal spine, half way between the scapular line and the spine, and correspond to the apices of the lower lobes.

What about the inner or hilus zone in infancy? The hilus in infancy and childhood is very labile, many of the disturbances that ruffle its contours being purely temporary in nature. The primary acute infections and, indeed, the acute infections of the bronchi secondary to the contagious diseases of childhood, often leave changes, roentgenographically demonstrable, more or less permanent, and frequently indistinguishable from those due to tuberculosis. In the infant as well as in the adult the hilus zone is therefore debatable ground, and the middle zone accordingly offers the most unobstructed field of study. Before closing my consideration of some of the difficulties which confront the roentgenologist in doing chest work, let me remind you of the wide variations in the apparently normal, and let me also commend most heartily the efforts of certain members of this Society to establish normal standards for the different ages.

INFLUENCE OF AIR CONTENT

Curiously enough, it seems to be forgotten, or at least unappreciated, that normal lung tissue casts a shadow in density in-

versely proportional to its aeration. Walsh, Wood and Thompson (6) emphasized this some years ago, but it needs repetition that fundamentally the delineation on the X-ray film of any part of the lung is largely dependent directly upon the air content of that part of the lung and also indirectly upon the air content of the neighboring, particularly the interposed, parenchyma. Compare the films of the lungs of the normal new-born infant before (Fig. 4 *A*) and after breathing (Fig. 4 *B*) has commenced, and note the dense uniform shadow of the atelectatic lung. Look also at the dense shadow (Figs. 4 *C* and 4 *D*) of the affected lung in that interesting condition known as massive collapse of the lung. This picture was taken from the article of Elwyn and Girsdansky (7). Recall the shadows of the compressed lung above a pleural effusion. Note the difference in the pictures of a chest taken, respectively, after full inspiration and after full expiration. Note the shadows due to localized atelectasis in cases of bronchial stenosis. Remember that endobronchial tumor is wellnigh impossible of demonstration on the film and that its presence can only be conjectured from the secondary changes in the unventilated lung. Finally, do not the well known shortcomings of the roentgenologic diagnosis of pleural thickenings, acute and chronic bronchitis, purulent bronchitis and bronchiectasis all warrant the statement that deviations from the normal in the roentgenograms of the lungs are more dependent upon aeration than upon histo-pathology, *per se?*

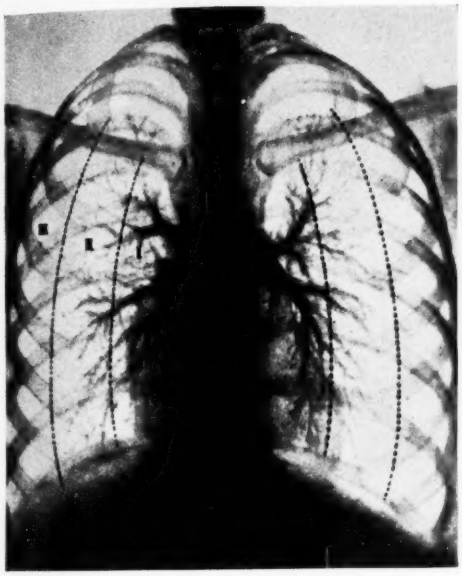

Fig. 3 *A*. Zones of chest of normal child, described by Dunham, Pancoast and Baetjer.

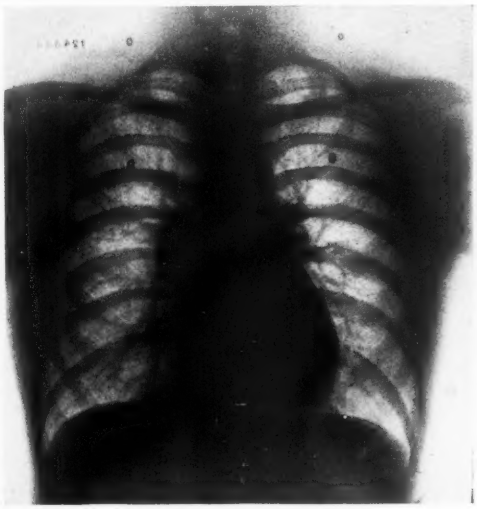

Fig. 3 *B*. The upper markers indicate Chauvet's "zones of alarm," the lower the apices of the lower lobes. (By W. W. Wasson.)

ACTIVITY

Let us turn now to the diagnostic significance of certain specific roentgenographic changes in pulmonary tuberculosis and the relation of air content to those changes. The correlation of the shadows on the X-ray film with the histo-pathologic changes in the tuberculous lesion has been well described by many writers, among them J. Burns Amberson, Jr. (8), Dunham (9), Skavlem (9), and in our Western country W. W. Wasson (10), S. B. Childs and Henry Sewall (11). Our convictions to-day may be summarized as follows: the specific tuberculous lesion, the developing tubercle with its zone of peri-

focal or collateral inflammation, appears on the roentgen film most commonly toward the periphery in the upper third of the lung field as a miliary opacity surrounded by a fainter shadow fading into normal lung den-

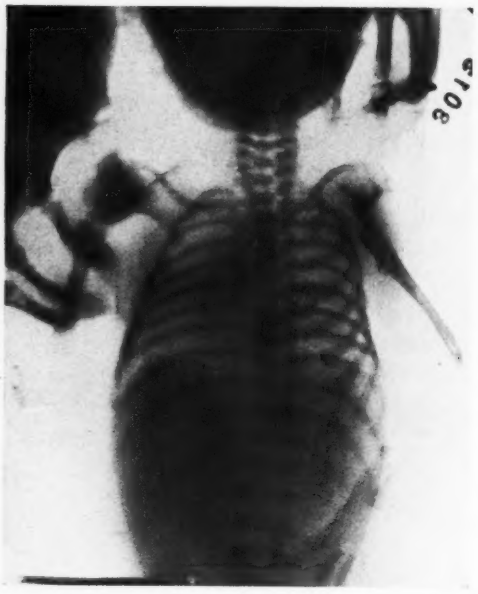

Fig. 4 *A*. Roentgenogram of chest of new-born infant before breathing. Note density of lung shadow and absence of air in stomach and bowels. (By W. W. Wasson.)

sity. As the allergic reaction in and around the tubercle subsides and fibrosis increases, the outer fainter shadow slowly fades and the central deeper opacity becomes both smaller and denser and therefore more distinct. Early, the relative preponderance of the inflammatory element determines the characteristic fuzzy cotton ball appearance; later, caseation, fibrosis and calcification increase and cavitation decreases the density of the central opacity. The increasingly sharp delineation of the isolated healing tubercle is due then to a number of factors, which may be summarized as follows:

A. Increased density of the tubercle from
   1. Caseation.
   2. Increased cellular content. (Proliferation of connective tissue cells and endothelial cells and lymphoid and polynuclear infiltration.)

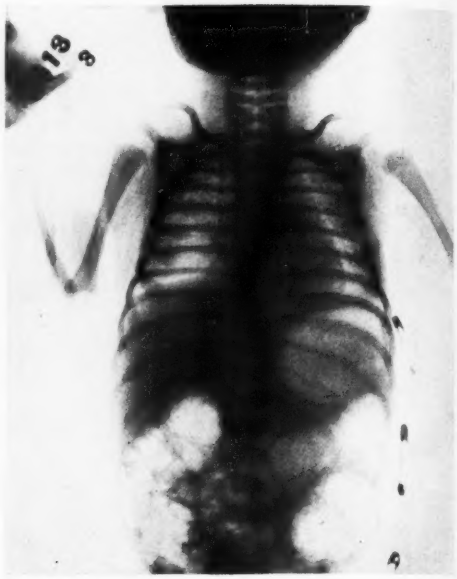

Fig. 4 *B*. Roentgenogram of chest of new-born infant after breathing. Note good pulmonary detail. (By W. W. Wasson.)

   3. Shrinkage due to connective tissue contraction.
   4. Calcification.

B. Decreased density of neighboring parenchyma by
   1. Absorption of peripheral intra-alveolar exudate.
   2. Resolution of cellular exudate and proliferated connective tissue cells in walls of neighboring air cells.
   3. Physiological emphysema.
   4. Pathological emphysema from contraction of radial and concentric connective tissue fibers in the shrinking tubercle.

In the last analysis the disappearance of perifocal haziness is due to better aeration, and better aeration is due partly to subsidence of the exudative reaction but also largely to the development of a zone of emphysema around the tubercle. The development of this surrounding pathological emphysema from the contraction of the connective tissue fibers in the healing tubercle

is beautifully depicted in the microphotographs illustrating the article of Leroy U. Gardner (12) on "Healing by Resolution." The microphotograph shown as Figure 5 is taken from this article of Gardner.

Viewed broadly, the expression "cottony" is most accurately descriptive of the early process, "mottling" of the moderately advanced, and "honey-combing" of the advanced lesions with excavation. "Activity" is estimated on the film by perifocal haziness and relatively slight opacity. The determination of activity by shadow alterations during the tuberculin test will have all the limitations of the tuberculin test itself added to the technical difficulties of catching on the film a reaction essentially microscopic. The usefulness of the method is therefore greatly restricted. It must be evident that the difficulties of estimation of activity are greatly magnified by the superposition of isolated and conglomerate shadows of recent and ancient processes located at varying depths and therefore more or less modified on the film. Since the art of diagnosis of tuberculosis of the lungs has not yet reached the point where clinical and pathologic activity, physical signs and roentgenographic findings can be accurately correlated, it would be wise not to use the terms "active" and "inactive" in our interpretations, but to substitute "recent" and "not recent," or "remote" (Wessler) (13), all preceded by the word "apparently." The terms "progressive" and "retrogressive" could be helpfully applied in subsequent reports on serial roentgenograms. For, even if it is perfectly apparent that the condition is recent and active, since caseation may be a preliminary step to resolution or to widespread dissemination, it cannot be told at any moment whether the retrograde process has or has not begun. Just as observations, not isolated but repeated at appropriate intervals, will inform a skilled mariner whether a ship on the horizon is approaching or drawing away, so serial roentgenograms must often be depended upon to determine the tendency of the pathologic process. It is unreasonable to ask the roentgenologist to render judgment upon an isolated observation, when often the clinician must repeatedly examine his patient and study the temperature curve for weeks before final decision.

Roentgenography has been of the greatest service in the early diagnosis of pulmonary tuberculosis not only because it has given a convincing demonstration that the X-ray can reveal unsuspected deep seated lesions, but because, properly used, it becomes an unexcelled method of post-graduate instruction in physical diagnosis of the chest. Unfortunately the general practitioner is showing a tendency to slur the physical examination and to rely on the X-ray for protection from gross error. Roentgenologist and clinician must not lose sight of the fact that the patient almost invariably looks to the clinician for the verdict. Furthermore the consulting radiologist occupies a different position in chest than in upper abdominal conditions. With trouble above or below the diaphragm, a good history easily secured from the patient, supplemented by a few well directed questions to the attending physician, will give the radiologist an adequate insight into the true state of affairs and place him in this particular quite or almost on an equal footing with the physician. Although more handicapped in lower than in upper abdominal conditions, the radiologist more than makes up for his restrictions by being able often through the fluoroscope and the study of plates to get a better idea of the patient's difficulty than the surgeon can hope to obtain. In chest conditions the situation is different,—the radiologist rarely if ever uses the stethoscope. Physical examination in these instances is limited for him to casual inspection, palpation and perhaps a few equally casual "thumps" with his percussing fingers. In their relative ability to acquire information by these methods of history-taking, physical examination and roentgen-

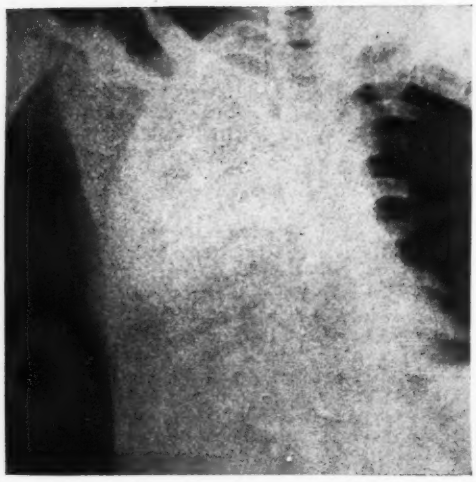

Fig. 4 *C.* Post-operative massive collapse of the lung. Note dense shadow of right lung. (Case of Elwyn and Girsdansky. Appearance of chest April 11.)

ography, I would compare the radiologist and the attending doctor as follows:

	Radiologist		Attending M.D.	
Methods	Chest	Abd.	Chest	Abd.
History	90	90	100	100
P. E.	10	70	100	100
Roentgen.	100	100	95	60
Total	200	260	295	260

The general surgeon can never hope to read a roentgenographic study of the ali-

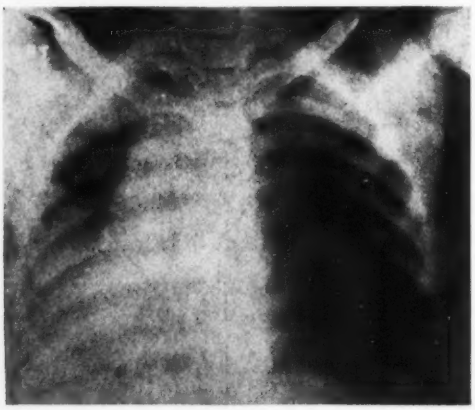

Fig. 4 *D.* Post-operative massive collapse of the lung. (Case of Elwyn and Girsdansky. Appearance of chest, April 19.)

mentary canal as well as the radiologist; in the reading of chest roentgenograms the specialist on chest conditions very soon acquires equal facility with the radiologist. In conclusion, in many abdominal conditions it would seem as if the radiologist was

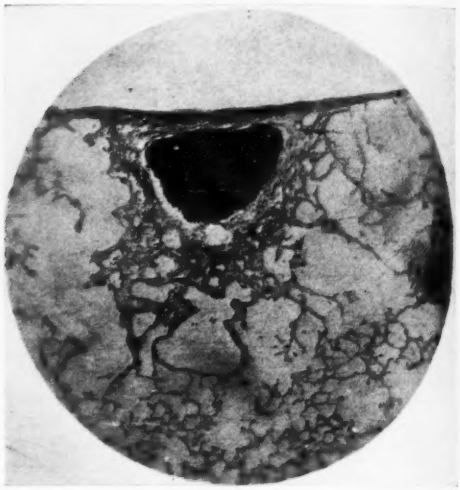

Fig. 5. Showing zone of emphysema around healing tubercle. (From L. U. Gardner.)

in equal or better position to make the diagnosis than the attending surgeon; in chest conditions the radiologist is in a much less favorable position to make the diagnosis than the attending physician. The business of making the picture properly belongs to the roentgenologist; the interpretation of the picture represents evidence secured at joint conference; the diagnosis is the responsibility of the clinician. The closest co-operation between these two, clinician and roentgenologist, is therefore essential to the best results.

CONCLUSIONS

1. The shadow of the bony thorax partly obscures nearly one-half the lung field in the infant and about two-thirds of the lung field in the adult.

2. The portrayal on the X-ray film of any part of the lung is largely dependent upon the air content of that part of the lung

and also upon the air content of the neighboring parenchyma.

3. The increasingly sharp delineation of the healing tubercle is due partly to increased density, partly to subsidence of perifocal reaction, and partly to the development of a zone of emphysema around the tubercle.

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Fibromas of nasopharynx.—The ages of the patients varied from ten to thirty-one years, the average being eighteen and one-half years. Twenty-nine (90.6 per cent) were less than twenty-five years of age at the time of examination. The activity of the tumor seemed to be directly related to the age of the patient.

Fibromas of the nasopharynx present a typical clinical picture; they have a definite life cycle, starting to grow about puberty, and continuing active until the age of about twenty-five years. The tumor is more amenable to treatment in older patients, since there seems to be a spontaneous retrogression after the age of twenty-three or twenty-five years. The tumor, which is hard, may be pedunculated or have a broad sessile base. It may have several attachments, due to ulceration, and may fill the greater part of the nasopharynx. These tumors are microscopically benign and clinically malignant; they do not metastasize, but owing to their location and extension into the skull may cause death.

The surgical treatment of fibromas of the nasopharynx is usually attended with frequent recurrences, necessitating repeated operations, with a high mortality. The severe hemorrhage which accompanies such operations makes them hazardous.

The radium treatment was applied by three methods. In the first or early cases, a T-shaped lead applicator with a 50 mg. tube of radium in the trough was held in various positions against the tumor in the nasopharynx. The initial dose was usually a 50 mg. tube for from ten to fifteen hours. The posterior surface of the palate is protected with a lead retractor made of 2 mm. of lead covered with a rubber finger cot.

In the second group of cases, steel points, containing the radium emanation or the element, were inserted directly into the tumor. Three or four points were usually inserted, depending upon the size of the tumor.

In the third and more recent group of cases, emanation seeds, averaging 0.5 to 1 millicurie each, were implanted directly into the tumor, the number depending on its size. Such treatments are repeated in from six weeks to two or three months, depending on the reaction and the result of the previous treatment. The dosage of the secondary treatments varies greatly, depending on the progress of the case. The number of treatments required in the cases now cleared up varied from two to nine, averaging between five and six. The crusting and scabbing secondary to radium treatment may be cared for symptomatically by the use of oil sprays, potassium iodid internally, and so forth.

The authors believe that radium is the treatment of choice for fibromas of the nasopharynx. With its use, the usual operative mortality in these cases is avoided. In most of the cases the tumor cleared up entirely and in others it was held in check during its period of activity.

J. D. Camp, M.D.

Treatment of Fibromas of the Nasopharynx. Report of Thirty-two Cases. G. B. New and F. A. Figi. Am. Jour. Roentgenol. and Rad. Ther., Oct., 1924, p. 340.

A PATHOGNOMONIC RADIOGRAPHIC FINDING IN EARLY PULMONARY TUBERCULOSIS[1]

By I. S. TROSTLER, M.D., F.A.C.R., F.A.C.P., and ROBERT H. HAYES, M.D., CHICAGO

THE preliminary presentation of this subject, at the June, 1924, meeting of the Radiological Society by Dr. Hayes and myself, was not intended to be in the nature of a formal paper, and this is intended only as a further report.

Conservative radiologists have heretofore contended that there is nothing ever shown in a roentgenogram of the thorax that is at all pathognomonic of early pulmonary tuberculosis. Any of the X-ray shadows which are known to be produced by pulmonary tuberculosis might be produced by any one of several non-tubercular conditions.

Phthisiologists have for years used the test of injecting tuberculin subcutaneously and intramuscularly to incite an early case to reaction, so as to make it recognizable when there were insufficient findings to make a diagnosis otherwise. It was in this sort of case, the early one, that we wanted to show our reaction; so with that end in view we began making two flat films of each such case, one before and one after the reaction produced by what Dr. Hayes had injected as the proper diagnostic dose of tuberculin. The result in every case was that when any clinical manifestations of a focal reaction in the lungs appeared, we were able to show it in the film and in some instances considerable more was demonstrable in the film than by the usual clinical methods.

Dr. Hayes' technic is as follows: In a patient suspected of having an *early* pulmonary tuberculosis, he first applies a Von Pirquet (cutaneous) test to determine the amount of tuberculin he will inject. At or before this time one of us (I. S. T.) makes a roentgenogram. Dr. Hayes sees the patient the next, or the second, day thereafter, and at that time determines by the appearance of the Von Pirquet reaction the amount of tuberculin that he deems to be advisable and necessary to produce the focal reaction, and injects it.

He then directs that the patient continue the taking of his temperature, as he had previously done, and return in 48 hours. At this time Dr. Hayes again examines the Von Pirquet and makes a most searching physical examination. A second roentgenogram is then made.

My (I. S. T.) technic is as follows: A small piece of adhesive plaster is placed on the back of the patient directly over the spine of the fifth dorsal vertebra as a landmark. Patient is now placed prone upon cassette containing double screened duplitized film, while a mark in center of adhesive plaster is exactly centered under focal spot of the tube (I use a plumb bob to exactly center this). I use a 30 ma. radiator type Coolidge tube at 30 inches anode film distance, passing 25 ma. at 84 K. V. peak for 1-6 to 1-4 sec. for men weighing about 140 pounds. Patient is instructed to take a deep breath, and the flash is made during the peak of inspiration. He is directed to leave the adhesive plaster in place so that the next exposure will exactly register the same position. The film is developed at exactly 65° F. for 4 minutes in a fresh developing solution. This produces a moderately light, but fine quality film. The second film is made under *exactly the same conditions*, and developed *exactly* the same. A variation in development will defeat the purpose, as the same degree of density is necessary in both films for the test to be of the greatest value. It has been found as easy to be exact in this as to be haphazard, and we have found that it pays. The radiographic part of this test is easy to make, and the films obtained are easy to interpret, as well as a pleasure to study.

[1]Read before the Radiological Society of North America, at Kansas City, December, 1924.

The interpretation of the films presents no difficulty to the initiated. When there is a reaction there is an increase in the density in the area where the focus of tuberculosis has taken on the congestion produced by the tuberculin reaction, the lymphatics around infected tubercular glands show an infiltration around them, and there are usually found areas where there is a slightly increased density—where lesser degrees of involvement are present. This is in no way an activation of an old, healed tuberculous lesion, but it is a sort of stimulation to new energy of the focus to help throw off the infection. There would be no sense or reason for us to make this test in old healed cases, as they are usually easy to diagnose, but it is in the early indeterminate cases where there are really no lung findings, no râles or moisture in the lungs, and only the slight general symptoms, that our test has proved of greatest value.

Of course it must be definitely understood that this test is *not to be used except by those thoroughly familiar with the effects of tuberculin*, in conjunction with the radiologist. While there is no danger, a knowledge of tuberculin reactions is necessary for the determination of the proper dose needed. In some of our cases as much as .005 (five milligrams) old tuberculin has been used, while in others as small an amount as .0002 (two decimilligrams) has produced rather severe reaction on the patient and marked shadow increase in the film.

The first point that we want to stress is that in early pulmonary tuberculosis before there is any other diagnostic radiographic finding of definite value, where the lungs are dry, and without any evidence of pathology pointing directly to tuberculosis, but the patient shows only some of the early toxic and adynamic symptoms, this test, because of the focal reaction produced in the involved area, can be shown upon the radiographic film.

The second point is that this focal reaction, being produced by the action of tuberculin, *is a specific reaction* and when found on the radiographic film of the same physical characteristics, made after the production of the reaction (of the same individual), must of necessity be as surely diagnostic of tuberculosis as anything can be. The reaction will not be stirred up if there is no tuberculosis present, nor will it stir up a reaction if some other disease is present and tuberculosis absent. *It is a specific tubercular reaction*, and the shadow of this specific tubercular reaction *must be as specific* and, consequently, pathognomonic of tuberculosis.

Again, let me say that we do not need this test in frank, outspoken tuberculosis or in old fibrous or healed tuberculosis, as these types generally show enough in the film to tell the story without a doubt. It is only in the early cases that this is needed and useful, but here it is invaluable. Dr. Hayes says that there is no danger in its use in proper hands. He says that the patients in whom we have applied the test have been benefited by the reaction that he has produced by the injection. He has used the injections without showing the reactions upon the films, for years, and has never found them to be of any damage or injury, so we may feel safe in their use.

Neither the production of the focal reaction nor the making of radiographic films is new; but the combination of a film made before the production of a tuberculin focal reaction and another made under exactly the same conditions, 48 to 72 hours after the production of this reaction and showing the infiltration upon the film is new, and we think a decidedly worthwhile finding.

X-RAY AND CLINICAL STUDY OF SOME PULMONARY LESIONS[1]

By MAX KAHN, M.D., and MARTIN F. SLOAN, M.D., Baltimore, Maryland

FOR the past six years the writers have jointly studied cases that had been examined previously by them as roentgenologist and clinician. This collaborated study has taught us that, from the standpoint of diagnosis, diseases of the chest may be divided arbitrarily into three groups: one which the clinician with the historical background and clinical procedures can diagnose accurately without the aid of the roentgen ray; another group which the roentgenologist solely with roentgenograms can diagnose and even prognose accurately, and a large third group which requires a careful combined study. In the course of our study we have encountered cases which had been incorrectly diagnosed by others, primarily because of this lack of collaborated study. Some of these possessed phases of such unusual interest as to seem worthy of presentation before this body.

For the purpose of study and presentation we have divided our cases into three groups:

I. Tuberculous
II. Non-tuberculous
III. Neoplasms.

TUBERCULOUS LESIONS

Very seldom is pulmonary tuberculosis diagnosed something else; most often are other diseases of the lungs diagnosed pulmonary tuberculosis. This is due perhaps in the main to the wide publicity given this latter disease. To many practitioners râles of any description in any part of the lungs usually mean tuberculosis, regardless of what the other clinical findings may be. Many poorly trained physicians doing roentgen-ray work, in their enthusiasm or ignorance interpret any slight abnormal change in the lungs as being of tuberculous origin. "Border line" cases of pulmonary tuberculosis, or those patients suspected of having incipient disease, are the most difficult and require the closest joint study. Influenced by the history the clinician is apt to find slight changes in the percussion note, whispered voice and breath sounds at an apex for which the roentgenogram reveals no pathological basis. The roentgenologist may at times interpret apical cloudiness as being tuberculosis, if the clinician is not present to advise him of intercurrent infections in the upper respiratory tract. In those cases where tuberculosis is suspected and the clinician and roentgenologist cannot find common ground to stand upon, the patient cannot be very ill and a policy of observation can safely be followed to await further developments. It is understood that disease of the chest, as elsewhere in the body, demands a well rounded investigation, such as a careful history, an evaluation of the local and constitutional symptoms, a skillful physical examination and a proper interpretation of findings, tuberculin tests, microscopic examinations, serological tests,—frequently cultures and animal inoculations and a careful roentgenographic study. The purpose of this paper is to emphasize the correlation of physical and roentgenographic findings.

Chronic infections of the upper respiratory tract may and do produce physical and roentgenographic changes which for years have been interpreted as tuberculous lesions. The physical findings are slight impairment of percussion note, suppressed rather than harsh breath sounds, and superficial fine râles. The roentgenogram reveals a hazy opacity not unlike the shadow of a thickened pleura. Under observation the râles prove transitory, according to activity in the upper tract upon which they are dependent; they are never moist and tubercle bacilli never appear in the sputum.

Chronic primary basal lesions have been considered in the vast majority of cases non-

[1]Read by Dr. Kahn before the Radiological Society of North America, at Kansas City, December, 1924.

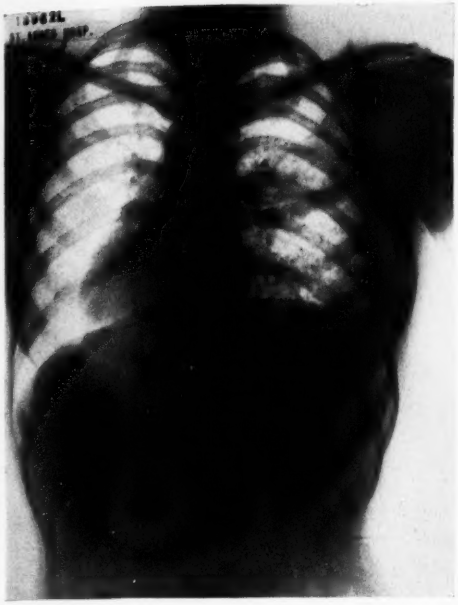

Fig. 1. Primary basal tuberculosis. Clinical findings suggested non-tuberculous lesion. Patient died of generalized tuberculosis.

tuberculous, but numerous exceptions are being established. The following is a case in point: The patient, a nurse aged 22 years, complained of temperature and weakness. Examination of upper respiratory tract essentially negative. Physical examination of lungs revealed an area of impairment in lower right interscapular area extending toward base. The breath sounds and whispered voice just inside the angle of scapula were harsher than normal, and there was a shower of fine dry râles to be heard in this vicinity. The laboratory findings, including sputum examinations, were negative. The clinical impression was that the lesion was a non-tuberculous infection. The roentgenogram revealed the following: Clear apices; left lung essentially clear throughout; hilum infiltration more than normal. Beginning about the fifth interspace on right, extending to base and out to periphery, there was a dense "fuzzy" infiltration. There were areas of consolidation and several calcified shadows included in the larger area of fuzziness. The shadows were considered as those of active tuberculosis. The latter diagnosis was accepted and patient placed on suitable treatment. She subsequently died of generalized tuberculosis.

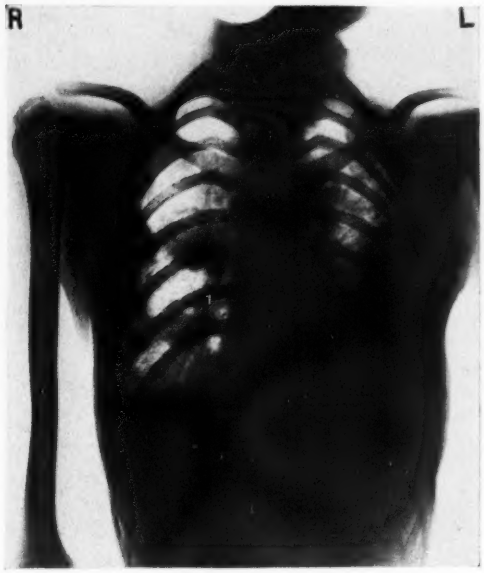

Fig. 2. Non-tuberculous metastatic infection of lungs. Primary lesion, insect sting on lip, followed by osteomyelitis of acromion process.

Three other patients in whom the physical examination revealed sparse but definite signs of infiltration at a base, without the slightest evidence of disease at an apex, were diagnosed "non-tuberculous infections." Roentgenograms made later revealed a distinct healed lesion at an apex. Tubercle bacilli were subsequently recovered from the sputum of all three. Most of the non-tuberculous lesions are massive ones and some of them, notably bronchiectasis, may be accompanied by tubular or amphoric breath sounds.

Bronchiectasis at an apex produces signs identical to those of a far advanced tuberculous lesion. A far advanced lesion with a cavity at a base overshadowing meager signs at the apex may be confused with an empty abscess or a bronchiectasis. A com-

bined study clarifies the confused situation better perhaps than sputum examinations.

NON-TUBERCULOUS LESIONS

Undoubtedly, the roentgen ray has been the most important addition to diagnostic

Fig. 3. Amoebic abscess, right base. Scrapings from wall of abscess revealed Amoebæ Histolyticæ. No amoebæ found in sputum or stools.

procedure since Laennec's stethoscope in 1815. As an instrument of precision its value is incalculable. We cannot forget Dr. Osler's warning against the use of mechanical diagnostic measures to the neglect of physical examination and bedside clinical study. We feel, however, that roentgenographic study should be made a part of every chest examination. It has done much to develop more accurate differential diagnosis of diseases of the chest and has played a large part in reducing tuberculosis morbidity.

BRONCHIECTASIS

Boy, age 11, was coughing and spitting blood. History revealed pneumonia three times prior to eight years of age. Eighteen months prior to visit he spat bright red

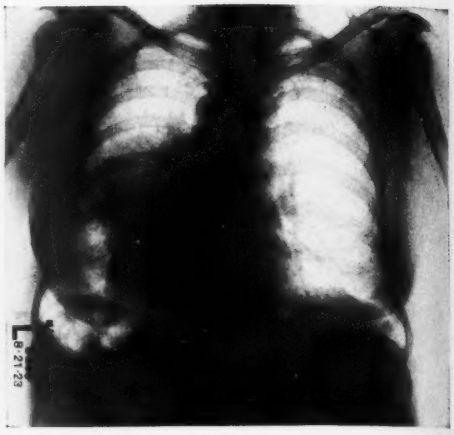

Fig. 4. Shadow, left lower lobe, due to streptothricosis; simulates walled-off abscess. Evidence also of healed tuberculosis in both lungs.

blood over period of four days. Diagnosis of pulmonary tuberculosis made by family physician. Since then has had attacks of coughing productive of large amounts of greenish offensive sputum. Recently has had several copious pulmonary hemorrhages. Examination revealed fairly well nourished boy, slightly cyanotic, with markedly clubbed fingers. Examination of chest showed large area of consolidation below inferior angle of left scapula, with a smaller lesion in the corresponding area on right side. Patient was inverted and about 200 c.c. of foul-smelling pus was expectorated. Diagnosis of bronchiectasis was made. Roentgenogram confirmed diagnosis. No tubercle bacilli have been recovered after numerous sputum examinations.

This is the lesion most frequently mistaken for advanced tuberculosis because of its history and its physical findings. Both lesions produce chronic cough and profuse expectoration and although tuberculosis is stressed in histories of blood-spitting, this symptom is just as constant and as profuse in bronchiectasis. The trained clinician detects causal difference upon which the diagnosis usually hinges. Bronchiectasis as a rule follows some other illness or accident; the sputum is usually massive and offensive;

Fig. 5. Bronchiectasis, region of left hilum and lower lobe. Heart completely displaced to right, apparently held by adhesions, simulating a cardio-dextra. Tubercle bacilli recovered from sputum.

the lesion is usually at the base, and inversion of patient produces a quantity of offensive sputum; in spite of the chronic history and extensive signs the patient is usually well nourished; the fingers are markedly clubbed (only slightly in tuberculosis).

The whole situation is confused when a patient with these signs and symptoms later shows tubercle bacilli in sputum, as follows: Male, age 67 years, seen September 1, 1922. *Complaint:* continued cough since previous March. Developed shortness of breath and cough at that time; has lost 30 pounds; recently has been raising large quantities of sputum in early forenoon; ten days before examination spat blood. *Physical examination:* Lungs (right): Impairment over upper front and back; breath sounds and whispered voice harsher than normal in these areas; no localized moist râles heard in this side; few dry ones in interscapular area. (Left): Area of dullness along the entire edge of sternum, extending out to anterior axillary line in 4, 5, 6 interspaces; tubular breathing and broncophony in 3 and 4 interspaces near border of sternum. Showers of coarse, medium and fine râles in this area. Heart: P. M. I. fifth interspace at left edge of sternum; soft systolic murmur at apex; not transmitted. Blood

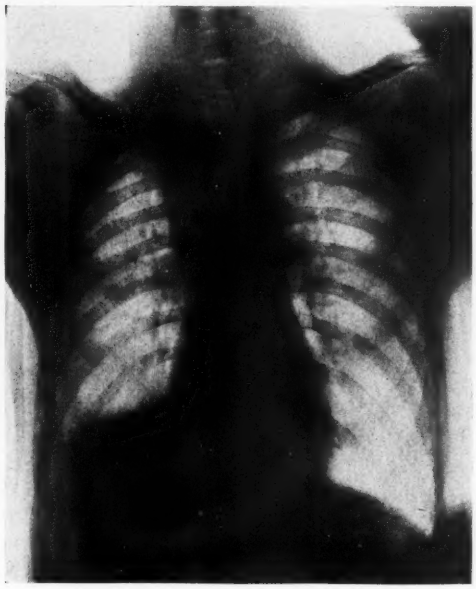

Fig. 6. Dense fibrous infiltration of right apex and upper lobe, extending downward toward the hilum. Infiltration simulated neoplasm, but was in all probability healed fibrous tuberculosis. Patient gave a definite history of tuberculosis.

vessels thick and tortuous. Blood pressure 150–60. Fingers markedly clubbed. *Diagnosis of lung condition:* Chronic pulmonary tuberculosis at right apex inactive; nontuberculous consolidation in lower lobe of left lung. Patient was inverted and spat 150 c.c. of thick greenish sputum with fetid odor. The basal lesion was considered bronchiectasis. Tubercle bacilli were recovered from sputum. Roentgenographic findings of the chest were as follows: Marked dense infiltration in the region of the left hilum and lower lobe. This infiltration extended outward into the lung fields, the base being at the spine, and was apparently composed of two areas, an upper and a lower, coalescing at the spine. The heart was completely displaced to the

right and was apparently held in this position by adhesions. It had the appearance of a cardio-dextra. The remaining left lung revealed fibrosis. The right lung was relatively clear. There were a few calcified shadows in both lungs. *Impression:* The

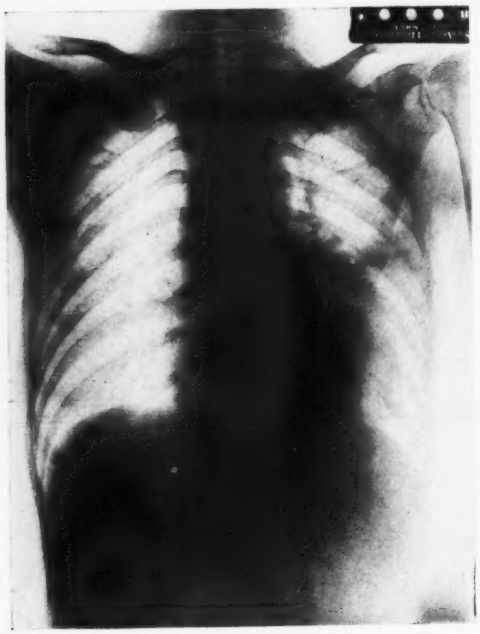

Fig. 7. Localized and well defined shadow in region of the left hilum, mediastinum and part of the left lower lobe, following pneumonia. In all probability a walled-off abscess.

infiltration on the left is suggestive of bronchiectasis, evidently of some years' standing. The displacement of the heart would also suggest an old inflammatory lung condition, with adhesions. On the whole, the infiltration did not suggest tuberculosis, but this was to be considered.

PNEUMONIC PROCESS

Female, age 15. Patient entered hospital August 4, 1924, with history of insect sting on upper lip, swelling pronounced. Ten days later she complained of pain in right shoulder joint. Roentgenogram revealed destruction of diaphyseal end of acromion process, suggestive of osteomyelitis. Part of lung showing in plate was seen to be infiltrated. Roentgenogram of chest was made and showed extensive infiltration of both lungs, with exception of apices, which were clear. There was a circumscribed area the size of silver half-dollar near hilus on right, and a larger area of dense infiltration was seen at base. Outline of diaphragm well defined; on the left a circumscribed area the size of a small peach, suggestive of unresolved pneumonia, was seen near periphery. The left base was homogeneously cloudy and suggested fluid. Three days later 300 c.c. of clear fluid was removed from left pleural space. Five days later the lungs were clearer; six days later they were essentially clear. Four months later the patient was clinically free of symptoms. She could not be persuaded to return for a "check-up" roentgenogram. The case is reported because of metastatic infection of right shoulder joint and lungs, following insect bite on lip.

Pneumonic processes at the apex simulate incipient tuberculosis very closely, not only because of their location but because of their signs and roentgenographic shadows. Last summer we saw two boys with such lesions, one following a tonsillectomy and the other a blow on the chest. Both had been diagnosed previously as having tuberculosis. It required no little courage to reverse the diagnoses, but by careful joint study it was done, and the subsequent courses of both cases have justified the reversal.

MYCOTIC INFECTION

Female, age 45 years, in January, 1923, developed a distressing cough, relieved only by large doses of opiates. Sputum occasionally blood-streaked. Temperature elevated as often in morning as in evening. Examination of chest in May revealed an area of impaired resonance, harsh breath sounds and whispered voice at spine of right scapula; no râles in this area. At the left base near the posterior wall there was another, but larger, area of impairment, with harsh breath sounds and whispered voice superimposed. There were a num-

ber of medium sized râles occurring in one shower over the entire lower left back, heard during cough. A few râles were heard toward the left apex and also at right base. A diagnosis of a healed tuberculosis of right apex and of a non-tuberculous infection at left base was made. Blood and sputum examinations were negative. Two months later a few streptothrix were recovered from the sputum. Patient subsequently died of a general streptothricosis. Roentgenographic findings were as follows: *Left lung*, the apex slightly cloudy. The upper lobe revealed moderate fibrosis, with peribronchial infiltration. There was a fairly dense shadow, apparently beginning at the hilum at about the sixth rib posteriorly, extending downward to about the ninth rib and outward in a circular manner to within an inch of the periphery. The outer border was not sharply limited but had a tendency to be slightly fuzzy. There were a few calcified shadows in the upper and inner part of this shadow. The base revealed moderate fibrosis. *Right lung*, the apex a little cloudy. There was moderate fibrosis throughout the lung, some increased infiltration in the region of the hilum, with numerous calcified shadows. There was a suggestion of adhesions to the diaphragm. There was no abnormal widening of the arch of the aorta. The heart appeared a little enlarged to the right and left. *Impression:* It was difficult to tell the exact nature of the shadow on the left. It had the appearance somewhat of a walled-off abscess. There was a strong suspicion of its being the end-result of some old non-tuberculous inflammatory condition. There was also evidence of healed tuberculosis of both lungs. The interesting feature of this case, aside from the streptothricosis, was the combination of a healed tuberculosis and an active non-tuberculous process in the same lungs.

FOREIGN BODY

Male (physician), age 53, in October, 1919, while eating chicken soup had a severe coughing and choking spell. In the fall he developed an occasional pain in right side, and cough. The following February he had "flu" and pneumonia in right side. Sputum repeatedly negative for tubercle bacilli. Cultures showed Staph. Aureus and M. Catarrhales. Physical and

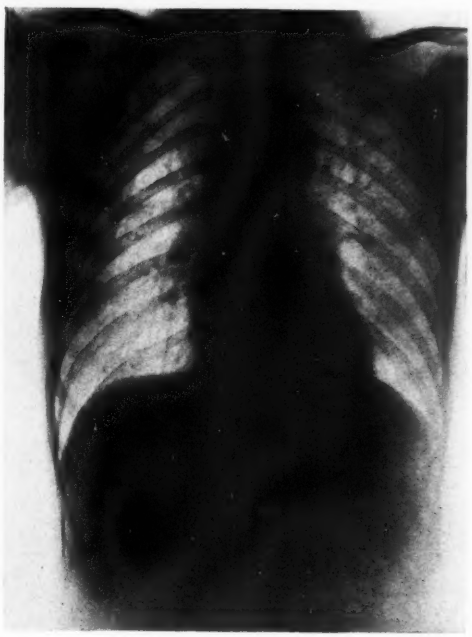

Fig. 8. Same case as Figure 7, three weeks later. Spontaneous rupture into bronchus, with disappearance of shadow.

roentgen-ray examinations in May revealed right apical fibrosis and dense right hilus shadow. No foreign body visible. Symptoms cleared in fall. In February, 1921, there was a recrudescence. Laboratory tests and animal inoculations inconclusive. In August the patient went to Saranac Lake for general rest. The impression there was "slight tuberculosis, activity right apex." On September 7 he had an attack of mental confusion; on the ninth he had a convulsion followed by unconsciousness. There was wrist drop of right hand. On the fifteenth he died. *Clinical diagnosis:* "Non-tuberculous pulmonary infection. Thrombosis cerebral artery." Necropsy findings revealed old tuberculous pleuritis right apex. A chicken vertebra was removed from lower

right bronchus behind sternum, near which were two small abscesses. There was a large abscess in right side of brain and a smaller one in left. Streptothrix were recovered from lung, brain, kidneys, and skin. Patient had been asked to

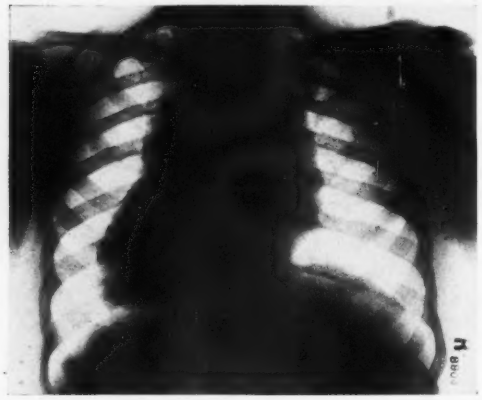

Fig. 9. Primary lymphosarcoma infiltrating mediastinum and lungs. No enlarged lymph nodes demonstrable elsewhere. Treated with deep roentgen ray.

bronchoscopic examination after first illness, but refused. Roentgenograms did not reveal a foreign body and bronchoscopic examination was not insisted upon. Certainly this was the thing to have done.

AMOEBIC ABSCESS

Male, age 38, complaint, general weakness. Had been coughing and spitting fetid sputum for two years, blood-streaked almost daily. Had lost fifty pounds in this time.

Positive physical findings: Marked anemia, unusual amount of pyorrhea, enlarged spleen. Area of lung dullness on right from third rib to liver from midclavicular to mid-axillary line. Breath sounds and whispered voice suppressed in this area, but a few fine râles were heard along upper border. Roentgenogram revealed the following: Apices slightly cloudy. From fifth rib to base on right there was a markedly dense, walled-off shadow with a translucent center. *Impression:* Lung abscess. Cavity drained by rib resection. Scrapings from wall showed numerous large Amoebæ Histolyticæ. No amoebæ found in sputum or stools.

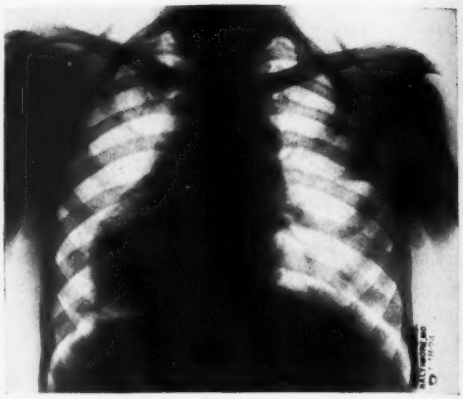

Fig. 10. Same case as Figure 9, five months after deep roentgen-ray treatment. Marked regression of tumor shadow only transitory.

BRONCHIOLITHIASIS

Female, age 25, complained of acute pain in right shoulder and chest and blood-spitting. Physical examination revealed unusually well nourished woman; the only positive findings were a few fine superficial râles in the neighborhood of fifth dorsal spine on right side and a lesser number in the corresponding area on left. The history and findings naturally suggested pulmonary tuberculosis. As the patient was about to leave the office she mentioned as an afterthought that she had spat up a pebble during a paroxysm of coughing. A small irregular stone, the size of a millet seed and of the consistency of a pearl, was exhibited. Roentgenographic studies showed chest practically clear for woman of 25 years of age, no evidence of stones in lungs. Had two subsequent attacks in the course of a month. There have been no further attacks in four years and she enjoys perfect health.

These few cases do not, of course, represent the entire list of non-tuberculous lesions of the chest. We have not presented

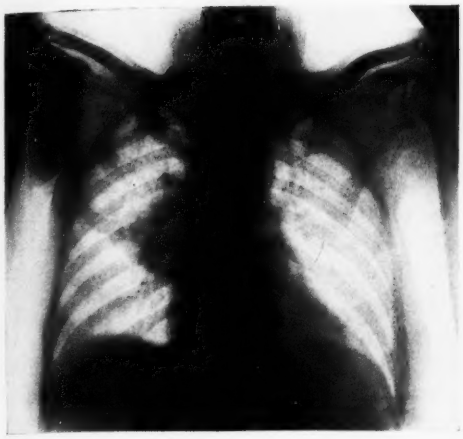

Fig. 11. Metastatic carcinoma, right mediastinum and lung, eighteen months after operation for breast carcinoma.

such conditions as syphilis of the lung, frank pneumonia, emphysema, pleurisy with effusion, echinococcus cyst, empyema or pneumoconiosis, mainly because of insufficient space and also because of lack of cases with unusual features.

NEOPLASMATA

Neoplasmata of the lungs and mediastinum are relatively frequent, and in our experience carcinoma occurs oftener than sarcoma. Primary carcinoma arises from the mucous membrane of either the esophagus or trachea and rarely from the remains of the thymus gland. Metastatic carcinoma is chiefly from the breast, prostate, ovary, etc. Metastases may sometimes be late and we have one case in which this did not occur until seventeen years and another case fourteen years after operation for carcinoma of the breast. We do not recall having seen calcification in either the primary or metastatic shadows. Roentgenologically it is difficult to differentiate between primary and metastatic carcinoma. Fluid in the chest which usually is bloody in character, not infrequently may be found associated with metastatic carcinoma and may obscure the tumor. A case recently referred for examination by Dr. Bloodgood is of unusual interest. The history briefly is that of a white female, age 62 years, who had her left breast removed July 6, 1923. On examination there were palpable skin nodules around the scar, resembling skin metastases. The liver was enlarged. A roentgenogram of the chest revealed fluid up to about the fifth rib on the left, but no

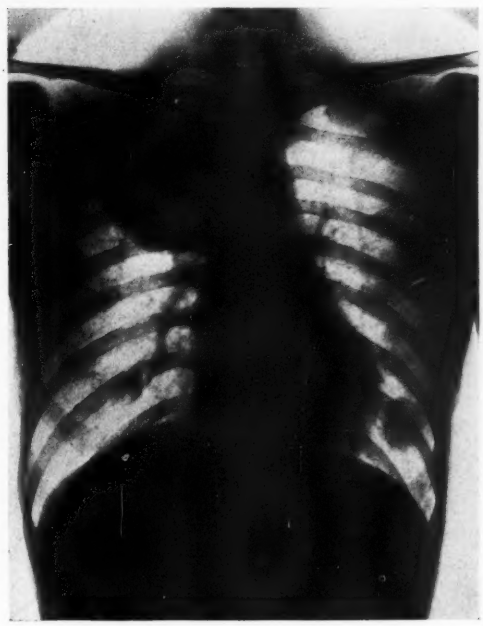

Fig. 12. Large rounded circumscribed tumor shadow occupying right apex and upper lobe. There are also smaller rounded circumscribed shadows in right and left lower lobes. Amputation of femur for periosteal sarcoma three years previous. The circumscribed rounded tumor shadows are quite characteristic of metastatic sarcoma.

definite tumor shadow could be visualized. The patient was suffering from pain in the region of the cardia, with marked dyspnea. The left chest was drained (rib resection) by Dr. L. C. Cohn. Five days later she died suddenly and a necropsy was performed one hour after death by Dr. Robert Kapsinow, revealing findings which were extremely interesting and rare in that there was carcinomatous infiltration of the pericardium and heart, and also that the drainage of the left chest had nothing to do with death. Necropsy findings were as follows: The body was that of a white woman, age about 60 years, already showing postmor-

tem lividity. There was a fairly large excoriation over the sacrum. In the left posterior eighth interspace there was an operative wound. The left breast showed a scar of a previous operation and there were many small B.B. shot nodules, extending for

Fig. 13. Dermoid cyst occupying greater part of right side of chest. This tumor was somewhat spherical and there was no expansile pulsation roentgenoscopically. The possibility of echinococcus cyst was considered because of its site. Cyst markedly adherent to the mediastinum and sternum so that it could not be completely removed.

a distance of two to three inches about the scar. The scar and adjacent tissues were firmly fixed to the underlying tissue. No masses were felt in the left axilla. Incision extended from the suprasternal notch to the symphysis. In cutting back the skin on the left side, through the thoracic wall, it was found that the tissue was firmly adherent and there were numerous points of almost hyalinized tissue extending through the chest wall, which, on section, appeared grossly to be cancerous tissue. In the lowest subcutaneous fat the shotty nodules, on cross-section, showed gross nests of cancerous tissue. There were no metastases to axilla. The right breast and axilla were negative. The thoracic wall was then removed but it was found that the external tissue of the anterior mediastinum was very firmly adherent to the sternum. The interpleural portion of the pericardial sac extended from the left side, and there was a mass of hard nodular tissue about the size of an egg, yellowish white in appearance, which cut like cartilage and was grossly cancer. The entire pericardial sac was thickened, leathery to touch, and showed patches of definite cancer infiltration. There were no adhesions between the pericardium and the heart. The fluid in the pericardial sac was normal in quantity and color. At the base of the heart the infiltration of cancerous tissue was enormous. It invaded the space around the aorta and pulmonary vessels, extending downward so that the entire muscularis and the right auricle was replaced by carcinomatous tissue. There were no areas of infarction. The heart was opened by Dr. Bloodgood after partial fixation in formalin. The muscle of the ventricle was about normal, but the entire heart was small in size. There was no endocardial invasion by cancerous tissue. The mediastinal lymph nodes showed no infiltration. The right lung was normal in consistency, adherent at the apex (probably due to an old tuberculosis), and there was no bloody fluid in the right pleural cavity. The section of the right lung was apparently normal. There were no evidences of cancerous tissue in the lung. On the left side the lung was found to be partially collapsed. There were four or five old fibrous bands which bound the lung to the chest wall and prevented complete collapse. The area about the operative wound was found adherent to the parietal pleura. There was a moderate amount of bloody fluid in this cavity. There were no evidences of metastasis. On gross section the lung was completely free of invasion. No evidence of pneumonia was present. *The abdominal cavity:* The peritoneum was smooth and glistening. The liver extended

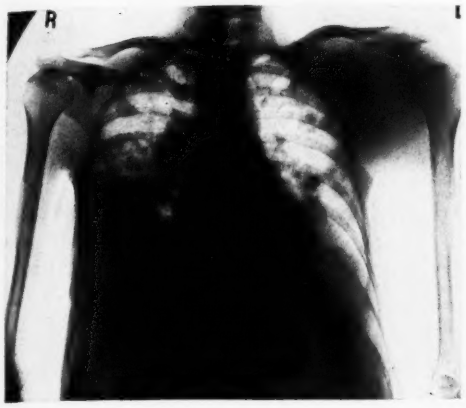

Fig. 14. Hypernephroma infiltrating lungs and mediastinum. There was also metastasis to left shoulder joint, with destruction of scapula. Metastasis to left humerus.

3 f.b. below the c.m. The omentum could be seen, studded with small bluish white masses of cancer tissue. The liver was removed *en masse*. On its parietal surface there were many small white areas, varying in size from 2 to 15 m.m., which on section showed definite carcinomatous invasion. The liver was cut in serial section by Dr. Bloodgood, but showed no invasion of the deeper tissue. There was no obstruction to bile flow in the duodenum. No stones were present. On section the common duct showed gross cancer. The head of the pancreas was removed because of the invasion of the biliary duct. It was hard, had a rubbery consistency, and showed carcinomatous invasion. The spleen was small, weighing about 110 grm., fairly firm in consistency and showed moderate degree of hyperplasia. The G. I. tract was negative. The kidneys were large, capsule stripped with ease. Kidney showed nothing grossly. The rest of the abdominal viscera were negative. *Primary cause of death:* Angina pectoris due to coronary obstruction by cancer tissue. *Secondary cause of death:* Metastatic carcinoma to the heart, pericardium, mediastinum, liver, gall bladder, pancreas, and peritoneum from primary lesion in the left breast.

Primary sarcoma is relatively infrequent, while metastatic is quite common, chiefly from sarcoma of bone. The metastatic shadows vary in size from that of a pinhead to that of an orange, are more or less circumscribed and button-shaped in

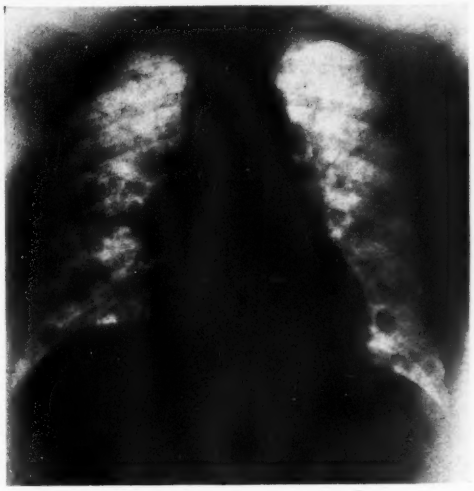

Fig. 15. Metastatic miliary carcinoma, seventeen years after operation for carcinoma of the breast.

character, and may be single or multiple. The single small shadows often escape detection, but the larger shadows may be easily recognized, and, when multiple, are often confluent. When situated near the region of the arch of the aorta they may be difficult to differentiate from an aneurysm, particularly if there is only a single shadow. Roentgenoscopic examination is of aid and may reveal either a solid tumor, lateral expansile pulsation of an aneurysm or both. Any sarcoma may produce metastases, but the chief source is from periosteal sarcoma. Metastases to the chest may at times be found early in cases of periosteal sarcoma, but the shadows may be so slight as to be almost unrecognizable. In advanced cases the lungs may be almost completely studded with rounded button-like shadows of varying size, and although deep roentgen-ray therapy over the chest will temporarily produce some absorption of these shadows and amelioration of symptoms, we know of no

case on record of a permanent cure. It is advisable, however, to treat the chest with the deep roentgen ray in every case of periosteal sarcoma, irrespective of a demonstrable metastasis, soon after the patient has had a course of treatment over the bone. Delay or possible prevention of metastasis to the lungs may result from deep roentgen-ray treatment early instituted, and it should be continued over a considerable period of time.

Lymphosarcoma may be either primary or metastatic and when metastatic it frequently is from the tonsil. It is manifested, as a rule, as a single wide shadow, and is often difficult to differentiate from Hodgkin's disease. The tumor sometimes grows to large proportions and may occupy the greater part of the chest. A case recently seen of a male, age 21 years, under our observation and treatment is of interest. This patient had a large wide tumor shadow in the region of the right and left mediastinum, extending into the lungs. There were no demonstrable lymph nodes anywhere, and we feel that this was a case of primary lymphosarcoma. He received deep roentgen-ray treatment which produced fairly rapid regression of the tumor at first, coincident with general improvement and increase in weight. He was kept under observation for about six months and received deep roentgen-ray treatment at intervals during this time. The blood pictures at the beginning and end of treatment were practically normal. About the fifth month he became gradually weaker and at this time there was also noted a gradual increase in size of the tumor, which appeared to be little influenced by further treatment. The first effect of the treatment was encouraging, the tumor being reduced to about one-third. which, however, was only transitory.

Hypernephroma of the lungs and mediastinum is always metastatic, and extremely infrequent. Roentgenologically the shadows are usually multiple, often confluent, and more or less circumscribed. There usually is metastasis to the bones at the same time. A case of this kind of a white female, aged 40 years, recently came under our observation, and, while no operation was permitted, the clinical history strongly suggested hypernephroma.

Dermoid cysts of the chest are comparatively rare. They arise in the mediastinum and vary in size from that of a walnut to that of a child's head. The small tumors remain in the mediastinum, while the large ones may extend outward into the pleural cavity. A few have been described as occupying the right base. In shape they are usually spherical, but may be flattened when in contact with the diaphragm. The cyst wall may be very thin or quite thick, and is invariably adherent to surrounding structures, most commonly to the pleura. Partial calcification of the cyst wall has occurred in a number of cases. Cholesterin crystals are a common finding, and in the majority of cases the cyst contains hair, epidermis, cartilage, bone, teeth, etc. A case of dermoid cyst of the mediastinum was reported by one of us in detail in the *Journal of Radiology*, March, 1922. The roentgenological study in this case is of interest in that a large rounded tumor shadow, occupying the greater part of the lower two-thirds of the right side of the chest, was found. Roentgenoscopically this shadow moved freely and revealed lung structure posteriorly and below. The liver shadow appeared somewhat depressed. No pulsation could be seen in this region.

PLEURAL EFFUSIONS, GENERAL AND LOCAL[1]

Their Detection and Differentiation by the X-ray

By WILLIAM H. STEWART, M.D., New York

THE character of the shadows cast by fluid in the pleural cavity depends entirely upon the quantity of the exudate and upon the presence or absence of adhesions. The most common finding in a simple pleural effusion of moderate amount is an obliteration of the costophrenic sinus by a dense shadow, with a concave upper edge, which extends from the outer border of the chest to the dome of the diaphragm. This shadow gradually extends upward as the effusion increases, always retaining its cup-shaped irregular upper margin, until the pleural cavity is entirely filled, when all the lung markings are obliterated and replaced by a dense shadow of homogeneous consistency. The effusion is then said to be "complete." In children, however, the effusion appears early in the axillary space, climbing up between the parietal and visual pleura from the diaphragm to the apex. It is detected roentgenographically as a ribbon-like shadow of increased density with a sharp inner border appearing in the outer zone of the chest. As the fluid increases, this shadow increases in width. Not until the inner border of the shadow reaches the outer edge of the inner zone does it tend to accumulate at the base. It then begins to extend upward in the inner zone while gradually increasing over the diaphragm, producing the characteristic concave upper border. This peculiar roentgen shadow continues to extend upward as the effusion increases until the entire side of the chest is filled with a dense shadow, indicating a complete pleural effusion. As the fluid increases, the heart and mediastinal contents are gradually displaced to the opposite side; this observation holds true in most children and is seen in many adults.

If pleuritic adhesions are present the effusion may become encapsulated, in which case the dense shadow cast by the fluid usually appears as a globular mass encroaching upon the lung structure from the cortex toward the root, the base of this shadow conforming to the shape of the chest. This sacculation may occur high up or at the base; it may be anterior or posterior. In many cases the location can be best ascertained by stereo-roentgenograms of the chest in the erect position, supplemented by lateral roentgenograms in the prone. Occasionally we have a case of pulmonary suppuration which breaks through into the pleural cavity. The resultant empyema has more tendency to become localized than general. If encapsulated, it may appear as an oval or circular shaped shadow having sharply cut edges; in fact, the density appears as though plastered upon the surface of the lung.

Many children when first examined show a complete empyema. It is only after the pus has been evacuated that the pulmonary suppuration comes to light.

Certain cases of pleural effusion, usually empyema, develop quickly during the course of a pneumonia, more commonly complicating a consolidation at the root than at the periphery. They appear roentgenographically as a general pleuritic haze which rapidly increases in density until all the pulmonary markings, including the pneumonia, are overshadowed. This sequence of events is quite common in children. Pleuritic effusions complicating pneumonia in adults are often difficult to recognize, especially if the pneumonia is in the lower lobes. If the pulmonary inflammation is in the upper lobes the effusion, when seen early, can be detected at the base by the shadows already mentioned.

Some cases first appear as a ribbon-like density between the lobes, indicating an interlobar pleurisy. This effusion may be entirely limited to the interlobar space,

[1]Read before the Radiological Society of North America, at Kansas City, December, 1924.

gradually widening out. The upper and lower borders of the shadow are usually sharp and well defined. We may have a secondary involvement of the entire pleura. At times the interlobar process does not appear until the general effusion is withdrawn. Examination in the lateral position in the prone, with the tube in front and the plate behind, or the reverse, has materially added to the discovery of this condition.

Some years ago the author made the somewhat startling statement that in children, especially, if the case was one of an empyema, the level of the fluid did not change perceptibly with the change in the position of the patient. Exception was taken to this observation by many clinicians who claimed that the physical signs did not sustain our contention. Nevertheless we still maintain that in children pus in the pleural cavity without the presence of air or gas does not change its level materially when the patient is changed from the prone to the erect, or, even, if everted.

Exception has always been taken to the statement that in the majority of cases of pleural effusion of considerable amount occurring in children, the heart and mediastinal contents are displaced to the opposite side. Years of experience still seem to confirm this early observation. In adults we frequently see exceptions.

The differential diagnosis between pleuritic effusions and other pulmonary lesions presents a most interesting phase of the subject. One of the difficult problems encountered is the differentiation between a complete pleural effusion and a complete pneumonia. The shadows are much the same. In children, however, we can rely upon the displacement of the heart to the opposite side as indicating a complete pleural effusion. In a pneumonia there is no displacement. In adults with no displacement of the heart we must frequently call for a reliable chest tap before we can decide. If the case can be examined frequently we will note that in pneumonia there will soon be a break in the shadows with evidence of some aeration.

Many of the conditions which produce extensive pleuritic thickening present a density similar to a complete effusion, except that in such thickening there is considerable fibrosis present, contractions of which draw the heart and mediastinal contents toward the affected side, the opposite to the condition observed in pleuritic effusions.

Consolidation in the lower portion of the upper right lobe is often mistaken for an interlobar pleurisy. While the lower border of the pneumonia is sharply limited by the lower border of the lung, the upper border fades away into the surrounding lung structure; the shadow of the consolidation is more liable to be wedge-shaped, with the base toward the periphery and the apex toward the root, while in interlobar effusions the upper and lower borders are sharp-cut and more or less parallel. As a rule, consolidation in the upper right lobe commences at the periphery, while interlobar pleurisy is frequently seen extending out from the root. Pneumonia of the middle right lobe is rare. When it does occur it is often mistaken for an interlobar empyema—at times aspiration is necessary in order to differentiate.

At times an encapsulated empyema, particularly if high up, on the right side, is taken for a cortical pneumonia. The latter process is always limited to one lobe and the shadow is distinctly wedge-shaped, with the base at the periphery and the apex toward the root; the edges of the shadow are rather hazy, while in an encapsulated empyema the shadow is not limited to one lobe and the inner edge is sharp-cut, usually circular in shape.

In the differentiation between lung abscesses and an encapsulated empyema the author can only repeat what he stated in a recent article published in the March, 1924, number of the *Annals of Clinical Medicine:* "To say by the X-ray whether the abscess is just beneath or just above the pleura is ofttimes impossible." In not a few the process is not only pleural but pulmonary as well. In these cases one has to depend largely on the clinical symptoms supporting

the roentgenographic findings before a decision can be made.

Some sacculated empyema cases have a pleuro-pulmonary fistula. The opening into the pleural sac may be near the top and just sufficient to allow the entrance of air, which accounts for the presence of air bubble above a fluid level simulating the findings in lung abscesses. In making the differentiation one must have a clear clinical conception of the entire course of the illness. The one symptom which usually aids is the presence or absence of foul-smelling sputa. This distressing condition indicates involvement of the pulmonary structures. One must also be confident that the air bubble is not the result of needling; sacculated empyema showing an air bubble above a fluid level, the air having been introduced through an aspirating needle, has more than once been mistaken for lung abscess. An encapsulated empyema, as a rule, is larger in size than a lung abscess. The three main points in the differentiation favoring pulmonary abscess are the presence of air in the cavity, the presence of induration around the cavity, and the profuse foul expectoration.

Cancer of the larynx.—Malignant tumors of the larynx have been treated surgically and by radiation. It is the author's belief that cancer of the larynx is not a surgical condition. He is now using electrocoagulation, which he thinks offers advantages not possessed by radium or X-ray. Time has been too short to justify an attempt at reporting results.

W. W. WATKINS, M.D.

Cancer from the Standpoint of the Otolaryngologist. Frank J. Novak, Jr. Wis. Med. Jour., Aug., 1924, p. 130.

Disease of the scaphoid.—This interference is due to low-grade infection, the source of which is unknown. This infection attacks the scaphoid for two reasons: Because the scaphoid is the bone in the arch of the foot which bears the greatest strain; because it has the poorest blood supply of any of the bones of the tarsus. Trauma undoubtedly has an influence in making the scaphoid susceptible to the infection. Clinically, the symptoms and signs are all those of a low-grade infection. In the previous pathologic examinations, the picture has been that of infectious irritation. In the writers' case, the picture is not incompatible with infection. The infection is so mild that ordinarily it is overcome by the resistance of the body, and development goes on with an approach to the normal. The writers believe that this is true in Legg-Perthes' and Schlatter's disease, and that treatment of this condition is of the greatest importance, because it is necessary to protect the damaged nucleus from strain and crushing, in order that flatfoot or weak foot may be avoided in later life. The treatment should correspond with that advised for Legg-Perthes' disease, and for slipping epiphysis of the femur—long-continued rest. This rest should be in plaster-of-Paris with the foot in strong over-correction in varus and cavus. It should be continued for from two to three months.

W. W. WASSON, M.D.

Koehler's Disease of the Tarsal Scaphoid or Os Naviculare Pedis Retardatum. F. C. Kidner and Felipe Muro. Jour. A. M. A., Nov. 22, 1924, p. 1650.

Tumor susceptibility to radium emanation.—From experiments conducted upon 143 control animals and 337 irradiated animals, the author concludes tentatively that preliminary irradiation of suckling rats with radium emanation is practically without influence upon the susceptibility of these animals to Flexner-Jobling rat carcinoma. There are, however, indications that the suberythema doses or mild radiations confer a very slight immunity, while larger doses have the opposite effect. Such action, if it exists at all, is so slight that experiments with several thousand animals would probably be necessary to definitely settle the question involved.

SOLOMON FINEMAN, M.D.

The Influence of Radiations from Radium Emanation upon Tumor Susceptibility in Albino Rats. Kanematsu Sugiura. Jour. Cancer Res., Oct., 1924, p. 376.

NEWGROWTHS OF THE LUNG, PRIMARY AND SECONDARY[1]

Their Classifications, Characteristics and Differential Diagnosis

By LEON THEODORE LEWALD, M.D., Professor of Roentgenology, University and Bellevue Hospital Medical College, New York

PRIMARY tumors of the lung are being recognized with increasing frequency, both clinically and roentgenographically. One clinician[2] states that he can recognize by means of physical examination, a tumor of the lung at a very early stage, even before it is recognizable on roentgen examination. This statement, however, requires further evidence from a series of proven cases. The use of artificial pneumothorax in the differential diagnosis of newgrowth of the lung is advocated by the same author, and should be more frequently utilized. "The writer[2, 3] has recently aspirated fluid in the chest and replaced it with air in the usual way in which a pneumothorax for therapeutic purposes is induced. A tumor is then made much clearer on the roentgenographic plate than can be expected otherwise. Similarly a diagnostic pneumothorax is induced in cases without fluid with a view of bringing out the outlines of an intrathoracic neoplasm."

Another authority makes the following interesting statement[4]: "A decade ago, the diagnosis of tumor of the lung was regarded as a brilliant accomplishment and a clinical *tour de force;* to-day it may truthfully be said that by a proper combination of clinical and roentgen evidence, few pulmonary neoplasms need escape discovery."

The importance of recognition of very early metastatic lesions in the lung or mediastinum cannot be too strongly emphasized. I have known of error, due to the positive diagnosis of metastatic growth of the lung when no metastatic lesion was present, lead to the withholding of an operative procedure and institution of palliative measures. The error is usually due to attaching undue importance to the peribronchial and root shadows. On the other hand, true early metastatic lesions should always be looked for before any operation for malignant growth is undertaken.

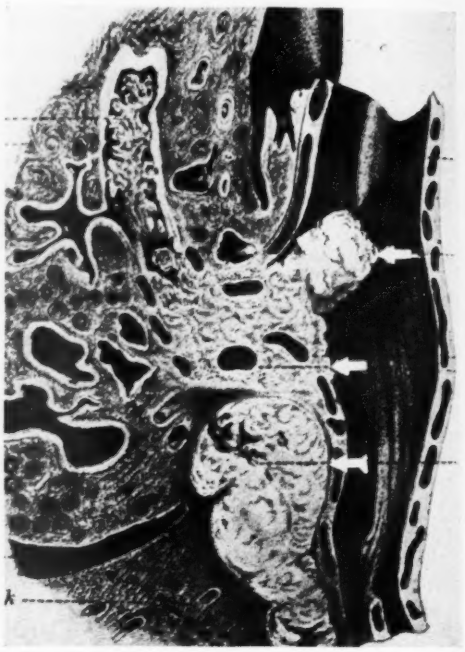

Fig. 1. Squamous-cell carcinoma of bronchus. (Taken from Ewing, Neoplastic Diseases.) Bronchoscopic examination would have been of great aid in this case.

Ewing[5] makes the following observations:

"Bayle, in 1810, vaguely described pulmonary cancer, and Stokes, 1842, recognized several

[1]Read at the Tenth Annual Meeting of the Radiological Society of North America, December 8-12, 1924, Kansas City, Mo.

[2]Fishberg, M. J.: Pulmonary Tuberculosis: Lea & Febiger, New York, 1922.

[3]Jour. A. M. A., 1921, LXXVI, 581.

[4]Wessler and Jaches: Clinical Roentgenology of Diseases of the Chest: Southworth Pub. Co., Troy, N. Y., 1923.

[5]Ewing: Neoplastic Diseases; W. B. Saunders Co., 1919.

varieties of the disease. Rokitansky recognized several gross varieties of the pulmonary lesions, but the earliest microscopical studies were those of Langhans, Marchiafava, and Malassez, 1871-1876.

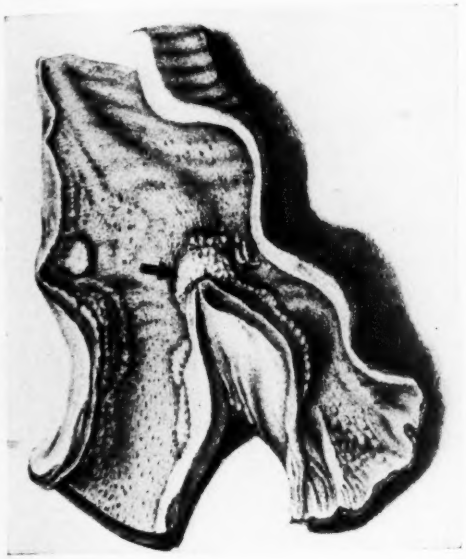

Fig. 2. Beginning carcinoma of bronchial mucosa. (Taken from Ewing, Neoplastic Diseases.)

"Primary malignant tumors of the lung form about 1 per cent of all cancers. Among 16,578 cancer autopsies from various Continental sources, 168 pulmonary cancers were recorded (compiled from Karrenstein and Adler). Kaufman places the proportion much higher—at 1.83 per cent. It is evident that increased attention has greatly augmented the list of observed cases.

"Males are much more frequently affected than females, 71.9 per cent to 24.8 per cent. Adler gives the following analysis of age incidence:

10-20 years	6
20-30 years	10
30-40 years	30
40-50 years	78
50-60 years	113
60-70 years	94
70-80 years	23
80-90 years	2
	356

"The right lung is more frequently affected than the left. According to histogenesis three groups of pulmonary carcinoma must be recognized, as arising from (*a*) bronchial epithelium (Fig. 1), (*b*) bronchial mucous glands, (*c*) alveolar epithelium. Squamous metaplasia of the bronchial mucosa has been shown to be of frequent occurrence in tuberculosis and other pulmonary lesions, and this change probably precedes the development of carcinoma in many instances (Fig. 2).

"In many cases squamous epithelium is mingled with cuboidal and cylindrical cells, as in Kretschmar's case, indicating the metaplasia may take place in the established tumor.

"*Sarcoma of lung.*—Old syphilis is strongly suggested in a curious tumor filled with mucus and pus, described by Milian and Mante. The precocious development of pulmonary tumors secondary to growths in other organs, especially in the bones, stands in the way of accepting certain bulky spindle-cell and giant-cell tumors as primary in the lung. Before sarcoma or carcinoma can be regarded as primary in the lung a very thorough search for primary tumors in other organs must be made. There are possibly on record less thoroughly studied cases than that of Lesieur and Home, who found a massive, apparently primary, carcinoma of the lung, but in the rectum a carcinomatous ulcer. Of the lymphosarcomas, very few, if any, can be regarded as primary in the lung, while in many instances it is clear from the anatomical descriptions that the tumor arose in the bronchial or mediastinal nodes or the thymus. It also appears that many authors describe as lymphosarcoma any tumor in which the cells are small and round. Nearly all the primary large and small round-cell sarcomas of the lung, as of many other organs, are under suspicion because of the fact that atypical carcinoma may yield exactly similar pictures in rapidly growing areas. Adler, among others, has pointed out the necessity of extensive study of all portions of such tumors and their metastases before the mesoblastic origin can be assumed. I can support Fuchs' statement that areas of spindle-cells may be found in pulmonary carcinoma. Hodenpyl found spindle-cells in the hepatic and lymphatic metastases of a carcinoma. The carcinosarcomas of the lung are thus explained.

"Finally, no one has succeeded in tracing the origin of any of the malignant sarcomas of the lung, and the general field of pathological changes in this organ does not point clearly to specific conditions under which mesoblastic tumors may arise. The very marked overgrowth of endothelium in some organizing pneumonias may perhaps have some significance.

"Nevertheless these uncertainties hardly warrant the conclusion, once drawn by Hertz, that

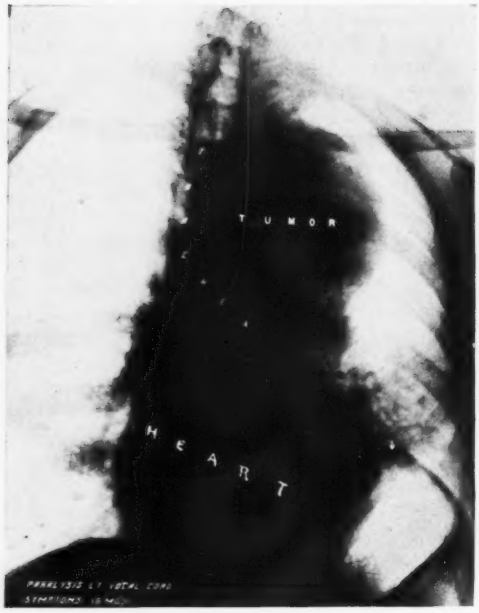

Fig. 3. Benign intrathoracic tumor, causing paralysis of left vocal cord due to pressure on recurrent laryngeal nerve. Probably a dermoid cyst. Note resemblance to aneurysm.

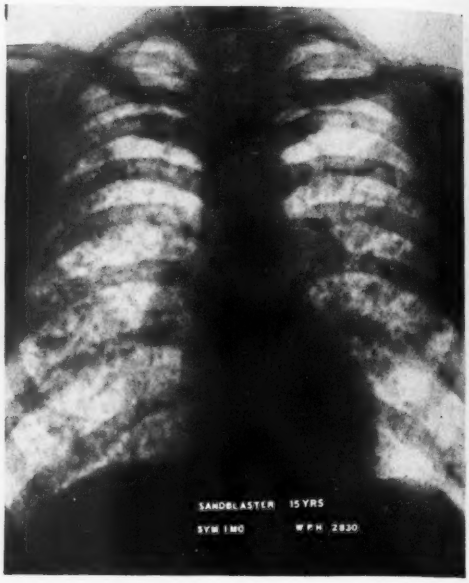

Fig. 4. Pulmonary fibrosis. Appearance resembles miliary metastasis of the lung, or miliary tuberculosis. History of occupation of sand-blaster for fifteen years.

primary sarcoma of the lung does not exist, for the literature offers not a few reports indicating that mesoblastic tumors occasionally arise in this organ.

"A provisional classification of pulmonary sarcoma based on anatomical features may be employed, as follows:

(1) Diffuse spindle-cell sarcoma,
(2) Peribronchial sarcoma,
(3) Large round-cell sarcoma,
(4) Lymphosarcoma.

"*Lymphosarcoma.*—Although a large proportion of the round-cell tumors of the lung have been described as lymphosarcoma, there is no satisfactory evidence that true lymphosarcoma arises in the pulmonary parenchyma. It seems much more probable that the lymphosarcomas arise in the bronchial or mediastinal nodes or elsewhere, and invade the lung along the bronchi. Such tumors present bulky masses about the hilum and more or less extensive invasion of the parenchyma."

Dermoid cyst has been encountered by me in a number of instances (Fig. 3). Short histories of a few of the cases follow:

Case 1. P. L., male, aged forty years, married, hod carrier. First seen April 14, 1916. Has had constant pain in the left side of the dorsal region, passing forward to the epigastrium, which is worse one to two hours after eating and in bad weather. There is no vomiting; appetite is poor and bowels regular. Pain interferes with work. *Physical Examination (lungs):* no changes in breath or voice sounds and no râles are heard. There is dullness to the left of the sternum from the second rib downward, continuous with the cardiac dullness and extending to the left for three inches from the midline of the sternum. The radiographic examination shows a rounded shadow extending above and to the left of the heart, 13.5 cm. from the midline of the body, which does not pulsate and which has a broad (6 cm.) extension downward in the midline behind the heart and reaching to the dome of the diaphragm. A side view shows the anteroposterior contours of the tumor to be also globular and that it is situated behind the arch of the aorta and the heart. The posterior aspect of the mass fits into a sort of bed on the anterior surfaces of four of the vertebræ, which are deformed in a symmetrical curve. It would seem that this development occurred during growth and that the spinal bones had been prevented from attaining their normal shape by the pressure of this neoplasm. This deformity presents a smooth, even surface, and in no sense can it be considered as an erosion or an inflammatory process.

Fig. 5. Miliary metastases from a tumor of the thyroid gland.

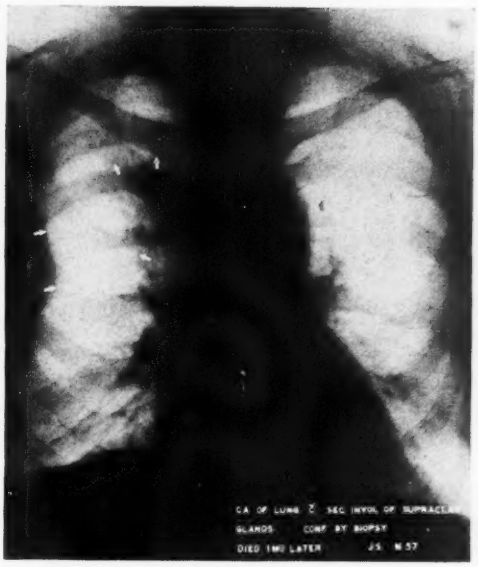

Fig. 6. Primary carcinoma starting at hilum. Secondary lesions in supraclavicular glands, proven by biopsy. Metastatic lesion near pleural surface of lung.

The patient has remained in good health except for recurring attacks of pain of a mild character. He has returned to work and still carried a hod in April, 1920. On April 11, 1920, the physical signs were unchanged from those of four years previous and a radiographic study of his thorax shows no changes from those originally found and described above. The original diagnosis of teratoma in the posterior mediastinum seemed justified by the presence of a large, smooth, globular tumor behind the heart, which has apparently caused by its mere presence developmental failure in the bodies of the fourth, fifth, sixth and seventh dorsal vertebræ to grow normally and has compelled these bones to form a concave surface on their ventral borders, closely applied to the posterior surface of the tumor. This diagnosis is substantiated by an entire lack of growth in the tumor during the four years of observation by X-ray examination, and especially from the side viewpoint, of showing no pulsation in the mass and of separating the tumor from the arch of the aorta lying in front of it. The absence of the pulsation, of thrill, of murmurs, of tracheal tug and of radial pulse variation are also confirmatory, although the radiograph taken in front places the tumor in the possible location of an aortic aneurysm.

Case 2. J. W., white, male, aged nineteen years, single, laborer. The patient came to the clinic of the New York University and Bellevue Hospital Medical College, January 25, 1916, complaining of headache, and stated that he had had headaches off and on for a period of two years, which had gradually increased in severity. In the course of a routine physical examination, made by Dr. E. J. Riley, it was discovered that there was dullness over the left side of the chest, with obscure physical signs. The Wassermann test was negative. A radiographic examination of the case showed a shadow to the left of the median line and above the left auricular shadow. It extended about 9 cm. to the left of the median line and about 10 cm. in vertical diameter. The edges were rounded and the lower border was superimposed upon that of the left ventricle. The shadow was as dense as the heart shadow. On fluoroscopic examination the portion of the mass near the heart seemed to show some movement, but it was probably transmitted from the heart. No definite expansile pulsation was made out. November 16, 1916, a second examination was made which showed a slight increase in the dimensions of the chest tumor. A third examination (March 5, 1919) showed a marked increase in the size of the chest tumor. It had reached nearer to the surface of the chest, having increased about 3.3 cm. in all directions. The heart was pushed to the right. It would seem that this case represented the commoner form of congenital tumor and that it was a true dermoid of the anterior mediastinum. The diameter of the tumor shadow has increased in thirty-eight months from 11.2 cm. to 14.5 cm.

CASE 3. J. K., male, aged thirty-seven years, married, plasterer. Born in Russia. This patient came to the clinic of the New York University and Bellevue Hospital Medical College, July 19, 1917. He stated he had been ill for five months with pain in his chest. On further

Fig. 7. Carcinoma of the lung. Ordinary exposure fails to show the rib involvement in this case. (See Fig. 9.)

questioning a statement was elicited that he had had pains in his chest for about twenty years. Physical examination disclosed dullness below the left clavicle. An X-ray examination disclosed a mass in the left side of the chest measuring about 8x12 cm. in diameter, extending from the heart shadow toward the lateral wall of the chest and about equal in density with the heart shadow. The edges were smooth and no expansile pulsation was seen. The case was observed for a period of about one year and no change in the size of the intrathoracic mass was seen. But nearly two years later the patient had an inflammatory condition of his lung and suddenly coughed up about 8 ounces of material, apparently from the dermoid cyst which had become infected. *Subsequent X-ray examination showed that the cyst had completely disappeared.*

Lambert[6] states that:

"Mediastinal dermoid cysts, or the more complex teratomata, are infrequent tumors, but may occasionally be diagnosticated antemortem. The roentgenographic findings are of great aid in the diagnosis.

"Symptoms due to pressure usually occur either in early childhood or during the second and third decades of life.

Fig. 8. Lateral exposure of case illustrated in Figure 7.

"About 10 per cent of the 79 undoubted cases reported have developed malignant characteristics.

"Surgical interference has proved of benefit in about one-half of the selected cases, with an operative mortality of about 27 per cent.

"No sharp line can be drawn histogenetically between the simpler cystic tumors and the complex and malignant ones. The latter are usually regarded as inclusion of a retrograde twin fetus, but other sources cannot be excluded. These theories explanatory of their genesis include a growth from isolated blastomeres, from polar bodies and from a parthenogenetic development of sex cells. The simpler cyst may in some cases arise from embryonic remnants derived from one or more of the germ layers."

METASTATIC TUMORS

Metastatic tumors of the lung are of very frequent occurrence, particularly following sarcoma of bones and carcinoma of

[6]Lambert, S. W., and Knox, L. C.: Intrathoracic Teratomata. Trans. Assn. of Amer. Phys., 1920.

the breast or other regions. Sarcoma may manifest itself by presence of a massive growth, which may rapidly involve as much as two-thirds of one side of the chest cavity.

Fig. 9. Carcinoma of the lung with involvement of the sixth rib. (To bring out detail in region of tumor, in order to study the overlying rib, it was necessary to over-expose the lung fields.)

In other cases there are numerous small nodules present in both lungs, varying in size from a few millimeters to two or three centimeters in diameter. When metastatic growth is in this form there is nothing roentgenographically to distinguish it from secondary carcinoma.

SECONDARY CARCINOMA

This may appear in either of two forms: Miliary type, in which it may at times be difficult to distinguish it from miliary tuberculosis, or fibrosis of the lung due to inhalation of dust in such occupations as sandblasting (Fig. 4) and stone-cutting.

Fishberg[7] makes the following remark:

"Miliary carcinomatosis, when hematogenous metastasis has taken place, produces a roentgen picture of the chest which cannot be differentiated from that of miliary tuberculosis. I have seen two cases in which this difficulty had arisen and it took some time before it could be cleared up. Usually the original neoplasm in some of the abdominal viscera, the thyroid, etc., can be found clinically, but now and then the diagnostic difficulties are perplexing."

[7]Fishberg, Maurice: Pulmonary Tuberculosis. New York, 1923.

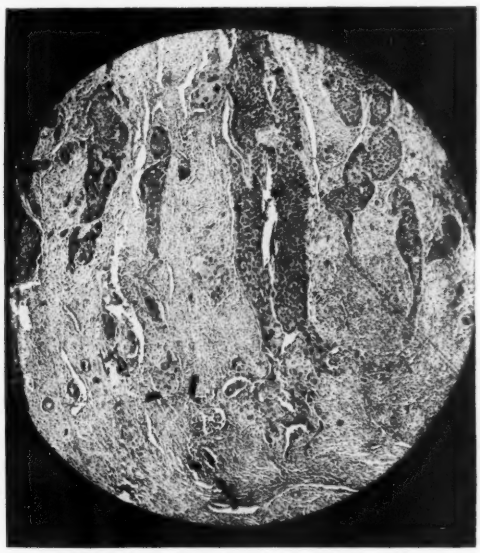

Fig. 10. Carcinoma of lung from case illustrated in Figures 7, 8, 9. Microscopical examination showed the neoplasm to be made up of embryonal epithelial cells differentiating into squamous type of cell and showing here and there a few epithelial "pearls."

The most typical example of this type is found in secondary newgrowth of the lung in cases of tumor of the thyroid gland (Fig. 5). The other type of metastatic carcinoma more frequently encountered is in the form of nodules varying from a few millimeters to a few centimeters in size; occasionally only two or three large nodules are found. A third type of metastatic growth has been described by some authors in the form of peribronchial lesions. This type of growth in its early stages is very difficult to distinguish from peribronchial fibrosis and the interstitial changes observed after roentgen treatment of the breast.[6]

PRIMARY CARCINOMA

In regard to the roentgen appearances of primary tumors of the lung it is necessary

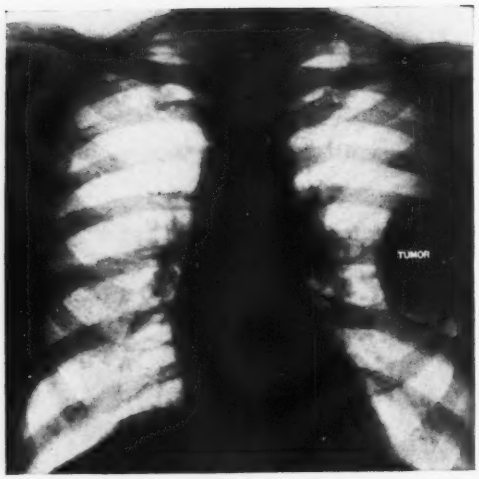

Fig. 11. Malignant tumor of the lung, apparently originating near the pleural surface, confirmed by exploratory operation and curettage.

Fig. 12. Lateral of case shown in Figure 11.

to divide them into three classes: (1) True pulmonary; (2) mediastinal growth (Fig. 6); (3) pleural growth (Figs. 7, 8, 9, 10, 11, 12). In the pleural growth a complicating clear or hemorrhagic exudate is frequently found and renders the diagnosis difficult. An authority on this subject makes the following statement[7]:

"One characteristic of effusions in cases of cancer of the lung is that they fill the entire pleural cavity; at least, flatness is elicited while percussing the chest from above the clavicle down to the diaphragm, and this is a sign which has hardly ever failed the writer in cases in which fluid in the chest was the first thing seen when the patient was examined. In inflammatory pleural effusions the resonance above the upper level of the fluid is more or less tympanitic—skodaic. In hydro- and pyopneumothorax, it is shifting. In cancer of the pleura or lung it apparently fills the entire chest, which is exceedingly rare, if it ever occurs, in effusions due to other causes in which there is at least resonance above the clavicle."

While this statement may be true, especially in cases without an antecedent history of some inflammatory condition of the lung or pleura, I am certain that in an inflammatory condition of the pleura I have seen one side of the chest so completely filled that the fluid reached a point well above the clavicle and caused displacement of the heart to the opposite side. The production of an artificial pneumothorax may be of great aid in making a differential diagnosis in these cases.

In regard to their nature primary tumors of the lung proper may be divided into two classes, benign and malignant. The benign tumors are distinguished roentgenologically by their failure to increase in size when observed over a long period of time (Figs. 13, 14). Occasionally a benign lesion of this sort may be of inflammatory origin. Of malignant tumors of the lung, the most frequent one is carcinoma. Two forms are recognized: (1) One which starts at the hilum and progressively involves more and more of the parenchyma of the lung (Fig. 4); (2) one of lobar distribution. The first type is usually in the nature of adenocarcinoma originating within a bronchus and spreading through the wall of the bronchus to the lung. The lobar carcinoma probably originates from the epithelial lining of the bronchi. The tumor cells are flat and may undergo metaplasia. The lobar type of carcinoma is most frequently found in the upper lobe. Occasionally a

tumor of this type may be found at the apex of the lung. Pancoast[8] has reported a group of tumors of this type. The tumors originating in the bronchi may occasionally be diagnosed at an early stage by bronchoscopic examination.[9] In Jackson's case re-

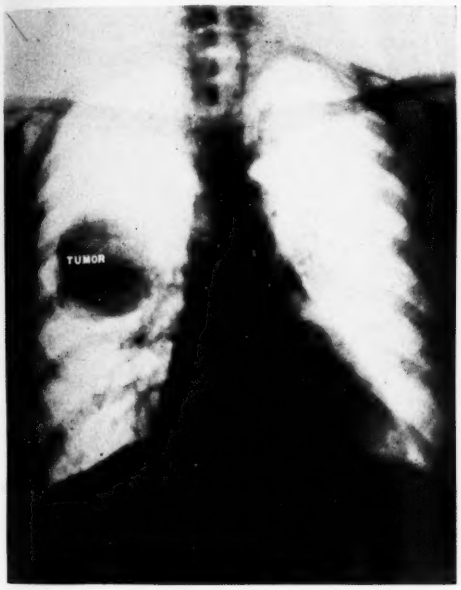

Fig. 13. Benign intrathoracic tumor, accidentally discovered during examination of digestive tract. No apparent increase in size of the tumor, one year later.

peated hemorrhages had led to a clinical diagnosis of pulmonary tuberculosis. Jackson, however, not only observed the tumor through the bronchoscope but administered bismuth, so that on subsequent roentgenograms the tumor was visible. Repeated X-ray examinations after an interval of a few weeks may be necessary to distinguish this type of carcinoma from heavy root shadows. If the tumor occludes a bronchus, secondary atelectasis may result. In some instances aneurysm of the aorta may give a similar appearance and even on fluoroscopic study fail to show definite expansile pulsation.

[8]Pancoast, H. K.: Jour. A. M. A., Nov. 1, 1924, LXXXIII, 1407-1411.

[9]Jackson, C.: Proceedings Laryngological Section, N. Y. Acad. Med., 1924.

HYPERNEPHROMATA

The metastases from hypernephromata are similar to those observed in carcinomata and usually appear in the form of numerous medium sized nodules scattered throughout both lungs.

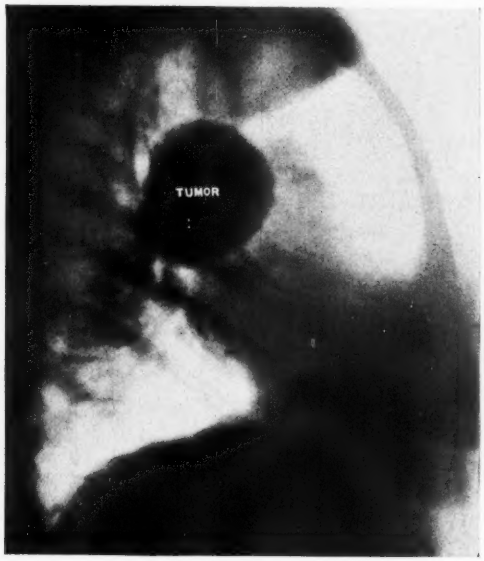

Fig. 14. Lateral exposure of case illustrated in Figure 13. Apparently larger size than in the anterior exposure, due to different factors in the exposure.

Tumors of the mediastinum show very definite changes due to increase in the breadth of the mediastinal shadows and may be distinguished from lymph nodes by the smooth border and extension over a greater area. These tumors are usually lymphosarcomata. Repeated examinations may be necessary to observe rapid increase in size of the tumor, which may assist in distinguishing it from Hodgkin's disease, tuberculosis, and enlarged thymus gland, or aneurysm of the aorta. Air injected into the pleural cavity may aid in the diagnosis, especially in distinguishing the condition from encapsulated effusions.

CONCLUSIONS

1. In attempting to make a roentgen diagnosis of early primary or secondary newgrowth of the lungs or mediastinum,

great care should be exercised in order to avoid the error of mistaking benign changes, such as peribronchial fibrosis or old healed quiescent tuberculous lesions, for a malignant condition. Repeated examinations over short intervals may be the only means of making a correct diagnosis.

2. Artificial pneumothorax should be used in making the diagnosis of lung tumor in doubtful cases.

3. Operative procedures should not be undertaken for the removal of a newgrowth in any portion of the body without first having made a careful roentgen examination of the lungs for evidence of metastasis.

4. The diagnosis of primary newgrowth of the lungs is being made with increasing frequency, owing to improved technic in both clinical and roentgen examinations.

Fibromyomata.—This paper discusses only fibromyomata. Cases should be carefully selected and only a skilled radiologist is qualified to treat such cases, in conjunction with the attending physician or gynecologist.

Indications for treatment.—Age of patient: as a rule best age is above forty; cases under forty may be treated but the treatments are more tedious. Nature of the fibroid: the interstitial form is most tractable, the multiple, subserous, submucous or adenomatous types being better treated surgically. Hemorrhage: fibromata with hemorrhage react more quickly to radium. Hemorrhage at the menopause, with or without fibroid, is easily relieved.

The contra-indications to radiation include calcified or degenerating fibroid; malignant or infected myomata; complications, such as salpingitis, pelvic peritonitis or ovarian cysts.

Fibromyomata up to the size of a five months' pregnancy are easily reduced; those larger than this are better treated by operation.

The conclusions of this author, based on over 300 cases, agree with those of the Mayo Clinic, as reported by Stacy.

W. W. Watkins, M.D.

X-ray and Radium in the Treatment of Nonmalignant Diseases of the Uterus. Lawrie B. Morrison. Boston Med. and Surg. Jour., July 3, 1924, p. 13.

Oxycephaly.—True synostosis of the coronal sutures does not normally occur until advanced life. The sagittal may close early without causing deformity, but not commonly. If the normal suture line is wholly or partly obliterated, the development of the bones follows an abnormal course. When the brain growth is more rapid than the capacity of the skull to expand, digital impressions, the effects of pressure, begin to show in the roentgenogram. In the author's cases a closure of the left coronal suture was recognized roentgenologically in one instance, and a closure of the sagittal and lambdoid sutures and possibly the left coronal, as well, in another instance. In a third case, occurring in a boy twelve years of age, the X-ray showed extreme convolutional atrophy of the inner table, closure of the frontal and lambdoid sutures, and a marked thickening of the edges of the sagittal suture. The importance of such cases is that in 50 per cent of synostitic cranial deformity blindness develops sooner or later.

Solomon Fineman, M.D.

The Importance of Early Diagnosis in Oxycephaly and Allied Cranial Deformities, with Reference to the Prevention of Blindness and Other Sequelæ. Harold K. Faber. Calif. and West. Med., Nov., 1924, p. 542.

ACUTE CONSOLIDATIONS OF THE LUNG[1]

Their Recognition and Differential Diagnosis

By L. R. SANTE, M.D., F.A.C.P., Associate Professor of Radiology, St. Louis University School of Medicine
From the Departments of Radiology of St. Mary's Hospital and the St. Louis City Hospitals

FOR the X-ray diagnosis of any lung condition, two things are essential: first, a thorough acquaintance with all stages of the pathological process involved, not only from the radiological standpoint, but also from the standpoint of gross and microscopic pathology; and second, a knowledge of the clinical symptoms accompanying the diseases.

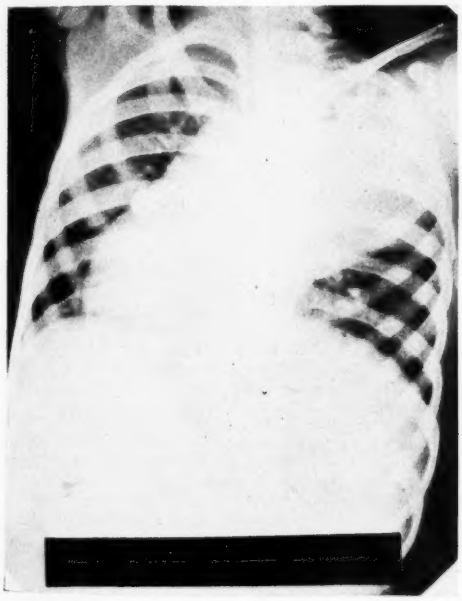

Fig. 1 (*a*). Lobar pneumonia of the right upper lobe. Note dense homogeneous shadow with abrupt straight line lower border.

The gross and microscopic pathology of the various lung diseases have been studied and are well known in all of their stages. This same information from a radiological standpoint can be secured by serial radiographic examinations of chest conditions following the pathological processes from their inception to their termination. This paper will be confined to the radiographic consideration of acute consolidations of the lung and their differential diagnosis.

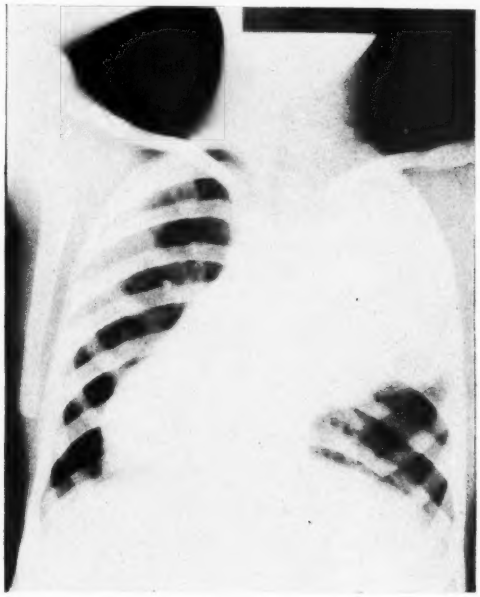

Fig. 1 (*b*). Acute (caseous) tuberculous pneumonia of the right upper lobe. Note dense homogeneous shadow with abrupt straight line lower border. The clinical history is not always sufficient to establish the differentiation from lobar pneumonia. Only the subsequent course of the disease suffices to establish the diagnosis.

1. Pneumonias (Pyogenic).
   - (*a*) Lobar.
   - (*b*) Hilus.
   - (*c*) Broncho.
2. Acute Caseous Tuberculous Pneumonia.
3. Lung Abscess.

Lobar pneumonia starts as a consolidation in the hilus region, rapidly spreading

[1]Read before the Radiological Society of North America, at Kansas City, December, 1924.

toward the periphery to involve one or more distinct lobes of the lung. This spread may be so rapid that at first examination, a few hours after the original chill, an entire lobe may be involved. If at first examination the consolidation is confined to the hilus region, re-examination after twenty-four hours should reveal an extension of the process to full lobar consolidation. The characteristic appearance of lobar consolidation of the various lobes is as follows: upper lobe consolidations show a marked increase in density, uniform in character, involving the entire upper half of the chest on one side or the other. The lower border of the shadow is abrupt and sharply outlined, and extends transversely across the lung field from the hilus to the periphery. Middle lobe consolidations occur on the right side and are characterized by a much less extensive shadow, having a straight line upper border, coincident in position with the lower border of the upper lobe consolidation. The lower border of the middle lobe consolidation shadow is hazy and "feathers out" into the normal lung field. Lower lobe consolidations are much larger and occupy the lower three-fourths of the chest, "feathering out" above as well as below. The costophrenic angle is the last part of the lower lobe to become consolidated. With establishment of full consolidation there is little, if any, change in the radiographic picture until after the crisis. At the time of the crisis there is no apparent change in the radiographic findings, but immediately following the crisis a marked change takes place. Resolution occurs very rapidly by absorption of the pneumonic exudate, with a re-appearance of the normal

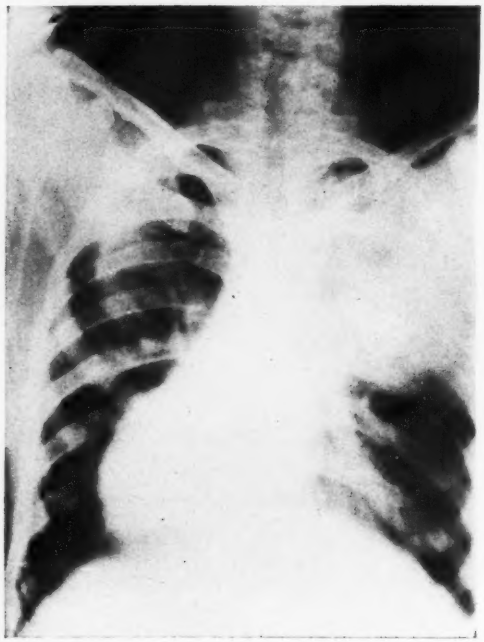

Fig. 1 (*c*). Lung abscess of the upper lobe, not yet ruptured. At this stage the differentiation from upper lobe lobar pneumonia can be made by the irregular lower border, more or less rounded at the outer margin.

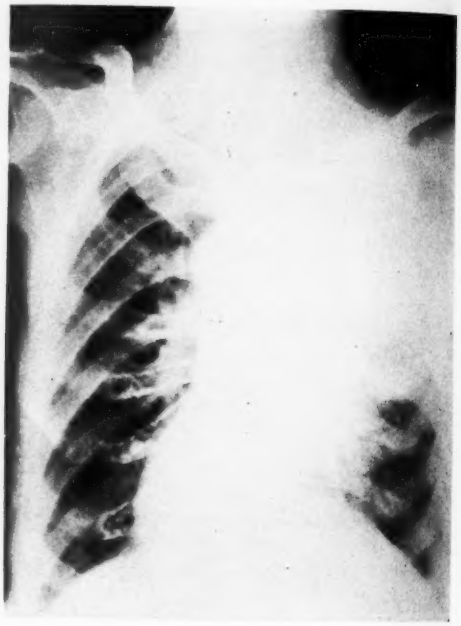

Fig. 1 (*d*). Primary carcinoma of the lung. Dense homogeneous shadow occupying the upper portion of the lung. The irregular lower border "feathering out" into the normal lung density differentiates the condition from lobar pneumonia. The fact that the consolidation existed for several months without inflammatory symptoms (temperature, leukocytosis, etc.) ruled out pyogenic infection. The absence of cavity formation ruled out caseous tuberculous pneumonia. Syphilis could not be excluded.

lung structure. Almost complete resolution may occur within three days after crisis. Such rapid resolution is unusual, however, seven to ten days being the usual time for complete resolution. This rapid resolution and restoration to normal is possible because of the character of the pathological process involved. The pathological lesion in lobar pneumonia is essentially a pouring out of a fibrinous exudate into the alveolar spaces, and consequently rapid resolution by absorption is possible, leaving the lungs apparently as healthy as before. Occasionally, in children, the consolidation of lobar pneumonia does not start in the hilus region, but at the periphery of the lung, and extends somewhat less rapidly in toward the hilus region. This is exceptional, however, and never has been noted in consolidations other than of the upper lobe. If three weeks after crisis there is still a persistent shadow without signs of progressive favorable resolution, you may be sure that you are dealing with some complication. The accentuation of the peribronchial markings is the last thing to disappear; with the final subsidence of the lymphatic and venous engorgement, these structures return to normal. The usual clinical symptoms, chill, high fever, rapid pulse and respiration, pain in the chest, herpes, and leukocystosis, accompany the condition.

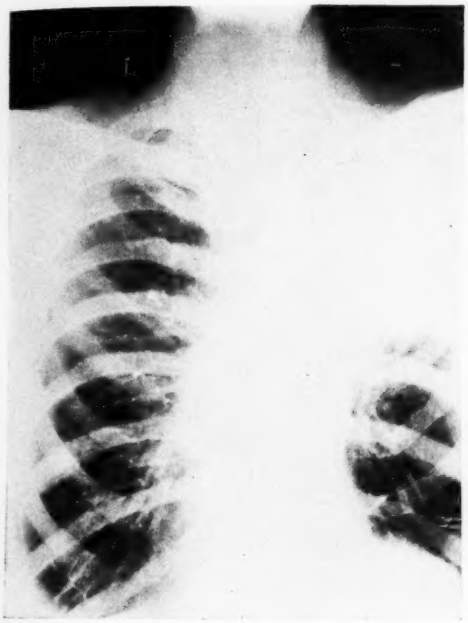

Fig. 1 (*e*). Localized pleural effusion of over one year's duration resembling consolidation. The shadow was dense and homogeneous; its lower border was abrupt; there was tracheal and mediastinal retraction toward the affected side. No febrile or inflammatory symptoms. The tracheal retraction led to a mistaken diagnosis of chronic fibrosis. Chronic fibrosis is never limited in this manner, however.

Fig. 1 (*f*). Localized pleural effusion of the usual type encountered in the upper chest, showing rounded inner border aeration near the mediastinum. Fluid is entrapped between the parietal and visceral layers of the pleura.

Hilus pneumonia, a pneumonia confined to the hilus region, which does not go on to complete lobar consolidation, has occasionally been noted. While no actual autopsy findings are available in this type of pneumonia since the condition never in itself proves fatal, it would seem from the X-ray findings that the pathological process present is much the same as that of lobar pneumonia, since both processes start the same and end the same—by crisis. Both show the same rapid resolution and restora-

tion to normal. It would seem, then, that the pathological process in hilus pneumonia which gives rise to consolidation is due to a fibrinous exudate. This type of pneumonia may be merely an abortive type of lobar pneumonia; abortive in so far as the process does not go on to complete lobar consolidation, not in the sense of a shorter duration of the disease, since the average duration of this type of limited consolidation is just as long as that encountered in complete lobar consolidation—seven to ten days. The condition is important, however, since the total lack of distinctive physical signs and the variation of clinical symptoms often baffle the clinician. The radiograph may thus clear up an otherwise obscure diagnosis. Clinically, the condition presents a rather characteristic picture. The onset may be with a definite rigor, but more often there are only chilly sensations. The pulse and respiration are rapid, but there is rarely the acute pain on respiration, experienced in lobar pneumonia. Pain on pressure between the scapula and spine on the affected side is a rather constant finding.

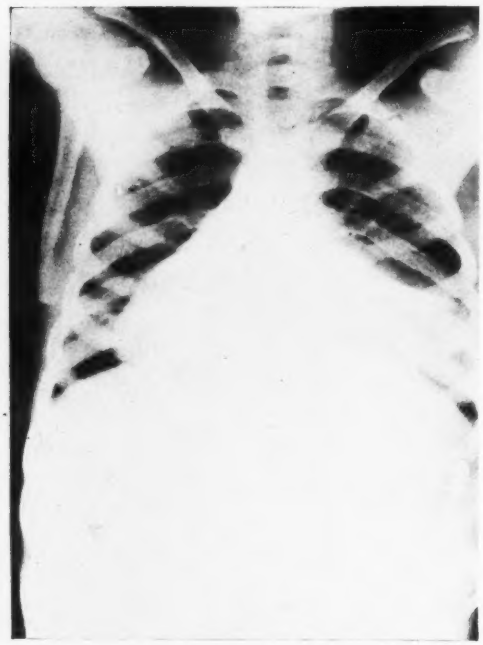

Fig. 2 (*a*). Right middle lobe lobar pneumonia. Note the straight line upper border and irregular "feathered out" appearance of the lower portion of the shadow, characteristic of middle lobe consolidation. Acute tuberculous pneumonia may resemble this condition. Localized interlobar effusions may be difficult to differentiate without the history.

Fig. 2 (*b*). Lobar pneumonia of lower portion of upper lobe, a rare form of onset of lobar consolidation in children. Note sharply outlined lower border which excludes possibility of middle lobe involvement. In twenty-four hours this shadow had spread to involve the entire upper lobe.

The sputum is bloody at some time during the disease, but is never of "prune juice" type. Defervescence is by crisis, and complete resolution usually occurs within seven to ten days. A few cases have been noted in which resolution did not occur and the condition resulted in a chronic tuberculous process,—probably activation of an old tuberculous lesion.

Broncho-pneumonia is essentially a different pathological process than either lobar or hilus pneumonia, and so manifests itself in the X-ray. Bacterial invasion of the peribronchial and vesicular structures is followed by inflammatory reactions where-

ever this invasion occurs, similar to the inflammatory reactions occurring elsewhere in the body as the result of infection. These colonies of invading bacteria, which the inflammatory reaction provokes, give rise, in the X-ray, to small soft peribronchial

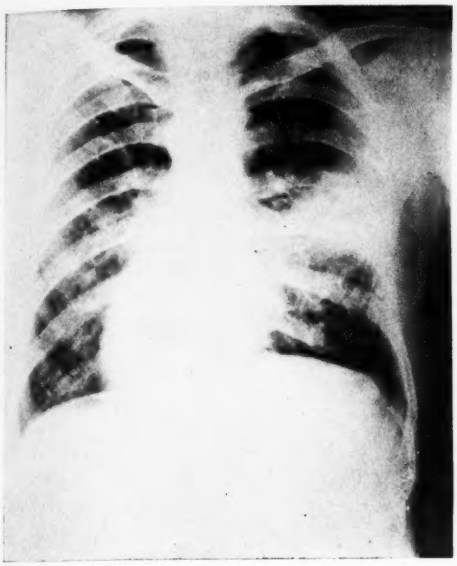

Fig. 2 (*c*). Interlobar effusion. Note the somewhat irregular appearance of the margins of the shadow. This is due to an associated plastic pleurisy. Where there is only an ordinary effusion the outlines are usually more well defined.

infiltrations clustered about the bronchioles, much in the character of a bunch of grapes. Such infiltrations occur usually in the lower lobes and the condition is most frequently bilateral. The individual infiltrations are soft in appearance, varying somewhat in size, from 5 to 10 mm. in diameter, in places coalescing to form larger areas of consolidation. Except in association with epidemic influenza these consolidations never take on lobar distribution and should never be confused with lobar pneumonia. The onset is usually less abrupt than in lobar pneumonia and usually follows a profound bronchitis or a cold. With development of pneumonic consolidation there is rapid pulse, high temperature—usually of a remitting type—and rapid respiration. As a rule the condition is not attended with the same pleural pain as lobar pneumonia. Defervescence is by lysis, and resolution is not complete for from four to six weeks. It is accompanied in the X-ray by a gradual disappearance of the consolidation, with final restoration to

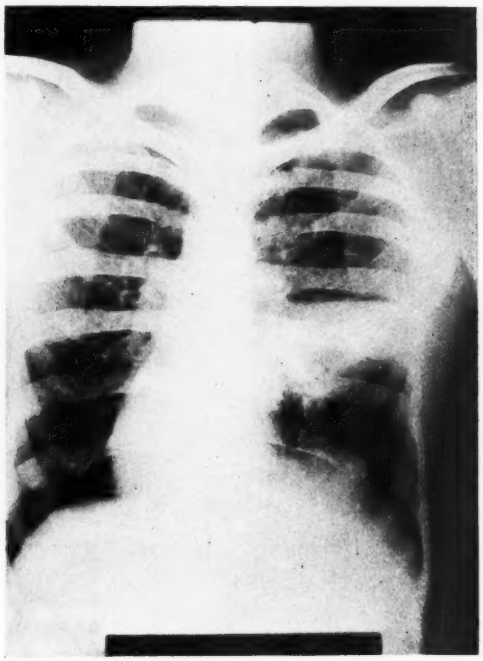

Fig. 2 (*d*). Pleural effusion localized between the parietal and visceral pleura of the posterior chest wall, resembling in many respects a middle lobe consolidation. The diaphragmatic adhesions betray the condition as one of longer standing. (See Figure 2 (*c*).)

normal. Here, likewise, the accentuated peribronchial markings are last to return to normal and the condition frequently leaves scars in the lung and adhesions which may be permanent.

Acute caseous tuberculous pneumonia simulates very closely, both radiographically and clinically, the picture obtained in lobar pneumonia: sudden onset, often with chills or chilly sensations, followed by fever, rapid pulse and respiration, and a varying degree of leukocytosis. These clinical symptoms are accompanied by a radiographic picture similar to that of lobar pneumonia, with complete consolidation of

an entire lobe (usually the right upper), and little if any demonstrable involvement in the remainder of the lung. The condition may be indistinguishable from acute lobar pneumonia and it is not until the time for crisis has passed and the condition has

Fig. 2 (*e*). Lateral view of Figure 2 (*d*), showing rounded pocket of localized effusion on posterior chest wall.

settled down to a more or less chronic process that the true nature of the disease is suspected. Examination of the sputum at this time discloses tubercle bacilli and establishes the true nature of the disease. The condition is chronic, and weeks pass before any changes are seen in the radiographic picture. Cavitation, months later, within the caseous consolidation is the result, becoming more fibrosed as time goes on. As a rule, however, the disease shows bronchial extension, and there is a progressive advancement of the lesion, and death.

Acute lung abscess, at its onset, starts as a dense consolidation in the hilus region, uniform in its density, and advancing peripherally in all directions without reference to lobe involvement. The character of the consolidation is in no wise characteristic of the disease and would be indistinguishable from a beginning lobar pneumonia at this stage. Clinically the condition simulates pneumonia, with chill, high temperature, rapid pulse and respiration, and pain in the chest.

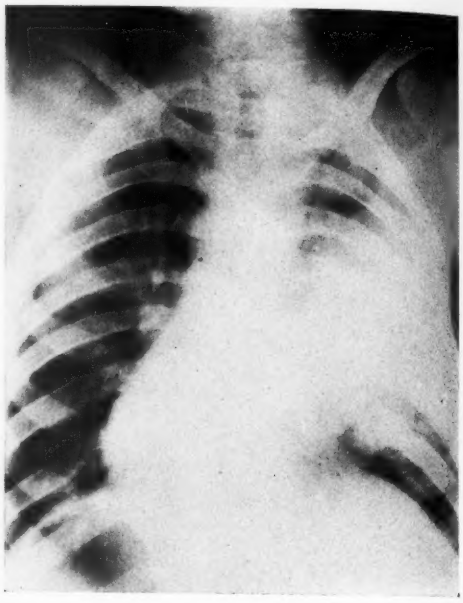

Fig. 3 (*a*). Lower lobe lobar pneumonia. Note the aeration of the costophrenic angle and lower portion of the lung. This is the last portion to become consolidated. With consolidation of the entire lobe the condition closely resembles effusion.

There is often bloody expectoration. The appearance of actual lung destruction in the form of cavity formation (even as early as the third day after the onset) clinches the diagnosis. Such cavity formation can occasionally be detected before the abscess has ruptured, but as a rule, since the pus itself is of the same density as the consolidation, this is impossible. Even when the abscess formation is very large, the surrounding zone of inflammatory tissue is more or less rounded in appearance. With rupture of the abscess the cavity becomes visible. This rupture of the abscess may occur either into a bronchus or into the pleural cavity. When the abscess ruptures into a bronchus and pus is entirely evacuated in this man-

ner, there is a rapid disappearance in the radiograph of the inflammatory zone surrounding the cavity, showing that this consolidation is composed largely of inflammatory exudate. Complete regression may take place very rapidly, so that no trace remains of the abscess. Complete disappearance of the abscess has been observed in nine days after rupture. This is rare, however, and complete restoration to normal usually requires three to four weeks. Persistence after four weeks of any evidence of inflammatory process is usually a very bad omen for ultimate spontaneous recovery. Chronic lung abscesses *have* undergone spontaneous regression, however, and in three instances in our own experience the previous duration of the disease had been seven months, nine months, and eighteen months. Occasionally the abscess ruptures into the pleural cavity, with or without pneumothorax, and results in empyema. After rupture of the abscess into the pleural cavity, the inflammatory process about the cavity and, indeed, the abscess cavity itself, may completely disappear, no trace whatever of the former site of the abscess cavity remaining. The results of the empyema and pneumothorax are readily recognizable. Lung abscess may either go on to complete spontaneous cure or pass over into the chronic stage. Clinically it is amazing what relatively slight clinical symptoms a lung abscess may give rise to, in exceptional instances, even in the acute stage. With no more symptoms than those attendant on a severe bronchitis, actual lung destruction may be going on. The course of the disease likewise may be confusing, especially in patients presenting mild symptoms. Passing from the acute to the chronic stage, with chronic cough, mucopurulent expectoration, afternoon temperature, night sweats,

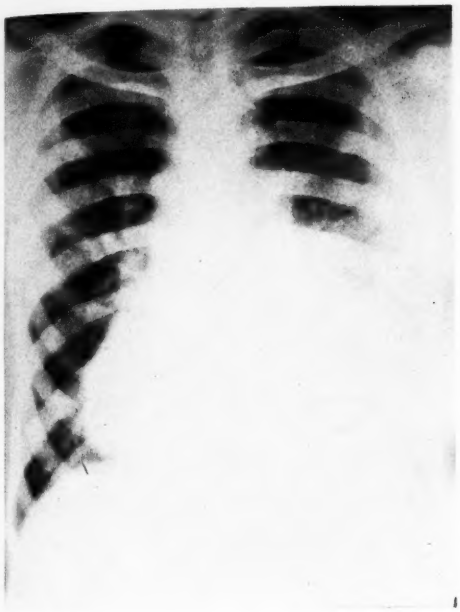

Fig. 3 (*b*). Acute lung abscess before rupture, resembling lobar pneumonia. A few days later the condition resembled effusion.

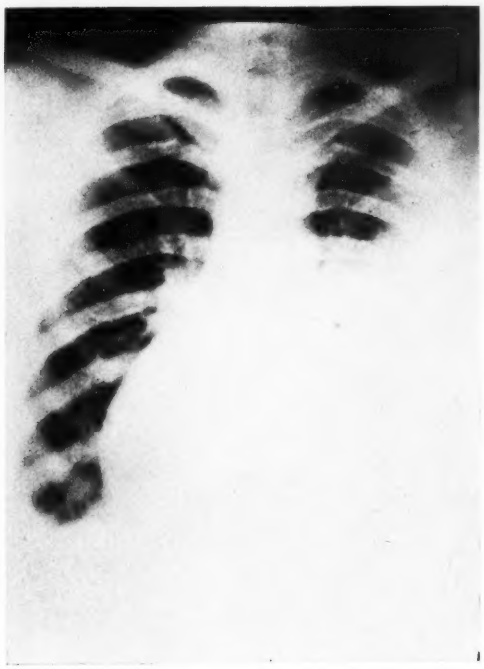

Fig. 3 (*c*). Acute lung abscess before rupture. The complete consolidation of the lower lobe might easily be taken for a large pleural effusion, provided this was the only plate available. Previous examinations had revealed the abscess cavity, however, and a few days after this plate pus was evacuated through a bronchus, the consolidation resolving rapidly.

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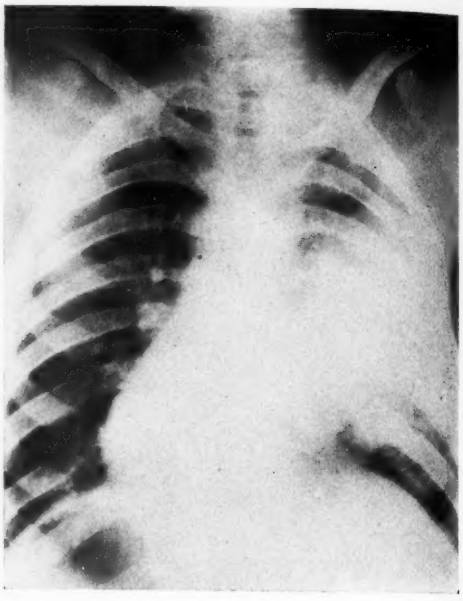
Fig. 2 (*e*). Lateral view of Figure 2 (*d*), showing rounded pocket of localized effusion on posterior chest wall.



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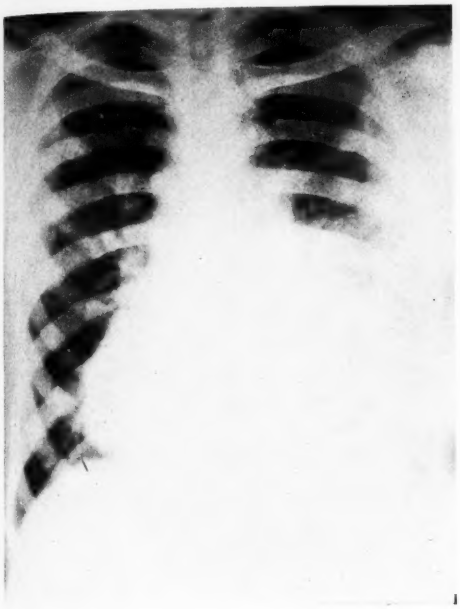

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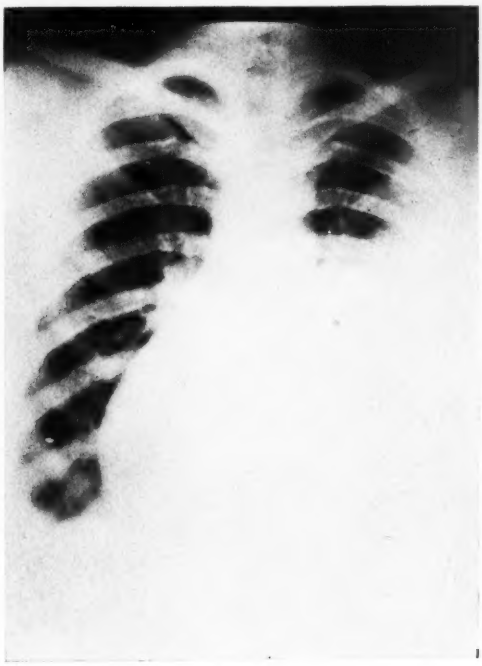

Fig. 3 (*c*). Acute lung abscess before rupture. The complete consolidation of the lower lobe might easily be taken for a large pleural effusion, provided this was the only plate available. Previous examinations had revealed the abscess cavity, however, and a few days after this plate pus was evacuated through a bronchus, the consolidation resolving rapidly.

loss of weight and often hemorrhages, the condition closely simulates tuberculosis.

In the differential diagnosis of chest conditions one fundamental fact is outstanding: it is necessary to correlate the X-ray findings with the clinical symptoms in all

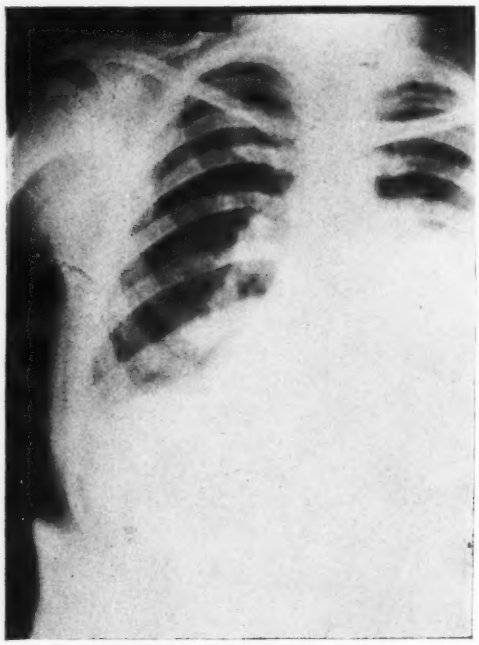

Fig. 3 (*d*). Massive secondary newgrowth; hypernephroma, resembling pleural effusion.

instances before a definite diagnosis is made. After a thorough analysis of the X-ray film, one may, in a large majority of instances, be able to come to a correct conclusion. Only too often, however, a thorough correlation with the clinical history is essential before a conclusion can be arrived at, which, in reality, becomes a determination of "the greatest degree of probability." In the systematic analysis of chest films certain points must be considered:

I. Presence of Pathology.
   Is actual pathology present?
II. Location and Distribution of Pathological Lesion.
   1. Is it in the
      (*A*) upper,
      (*B*) middle, or
      (*C*) lower portion of the chest, or is there
      (*D*) generalized involvement?
   2. Is it most pronounced in
      (*A*) hilus region (central), or
      (*B*) periphery?
   3. Is it
      (*A*) unilateral, or
      (*B*) bilateral?
   4. Is it
      (*A*) peribronchial, or
      (*B*) parenchymatous in origin?
III. Character of the Pathological Lesion.
   1. Is it due to
      (*A*) An increase in the peribronchial markings?
         (*a*) Are they soft and tortuous, as in recent lesions, or
         (*b*) are they discrete, and drawn out into straight lines, as in more chronic lesions?

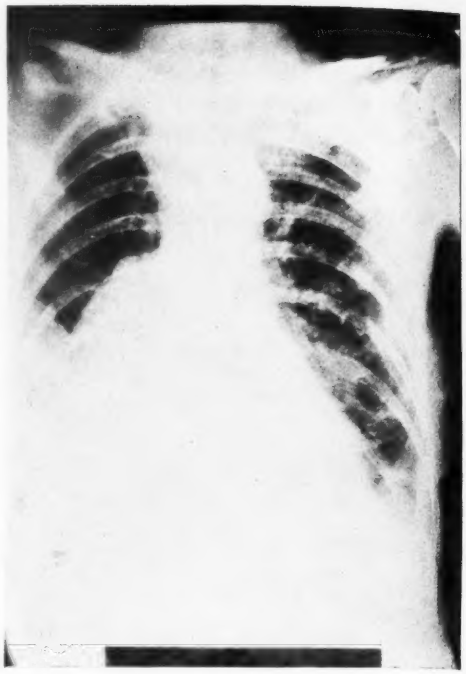

Fig. 3 (*e*). Large irregular shadow in the lower chest, resembling tumor. At autopsy the condition proved to be an old localized empyema.

(*B*) Involvement of the lungs?

(*a*) Increase in lung density?

(1) Is the shadow of uniform density throughout, as that found in exudates of lobar pneumonia, and pleural effusion?

(2) Is there a mottled appearance, such as that produced by coalescence of infiltrations of bronchopneumonia, or is the lesion composed of isolated infiltrations?

(3) Is the lesion

(*a*) soft in appearance, or is there the

(*b*) discrete appearance of fibrosis, or the

(*c*) dense appearance of calcification?

(*b*) Decrease in lung density?

(1) Is the rarefied area of

(*a*) uniform appearance throughout, showing no lung markings, as in complete pneumothorax, or

(*b*) is there evidence of lung markings showing through the rarefied area, indicating that any pneumothorax present is localized?

(c) Is there evidence of actual lung destruction, as in cavity formation from whatever cause, tuberculosis, bronchiectasis, or chronic abscess?

(*d*) Is an area of destruction surrounded by an extensive consolidation as in acute abscess?

(*C*) Involvement of the pleura?

(*a*) Simple pleural thickening, or

(b) plastic fibrinous pleurisy?

IV. Form or Outline.

1. Is the border of the lesion

(*A*) abrupt and sharply outlined, or does it

(*B*) "feather out" into normal lung density?

2. Does the lesion conform to involvement of

(*A*) any definite lobe of the lung? Is it

(*B*) more or less rounded without reference to lobe involvement?

V. The Relationship or Involvement of Surrounding Structures.

1. Is there narrowing of the chest cavity on the affected side?
2. Is there mediastinal retraction or other evidence of scar tissue formation?
3. Is there an enlargement of the chest cavity on the affected side, indicating increased pressure?
4. Is there mediastinal displacement to the opposite side?

VI. Change of Character of the Lesion on Change of Position

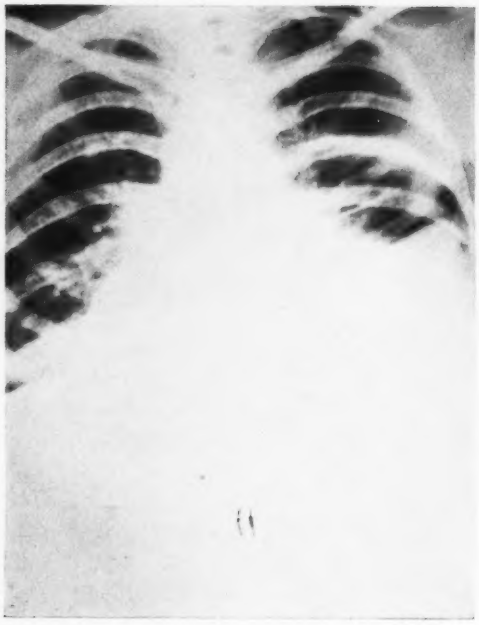

Fig. 3 (*f*). Dense shadow in lower chest, well defined and sharply outlined in its upper and lateral margins, very suggestive of newgrowth. Condition was due to a pleural effusion limited by the interlobar pleura to the lower portion of the chest. (See Figure 3 (*g*).)

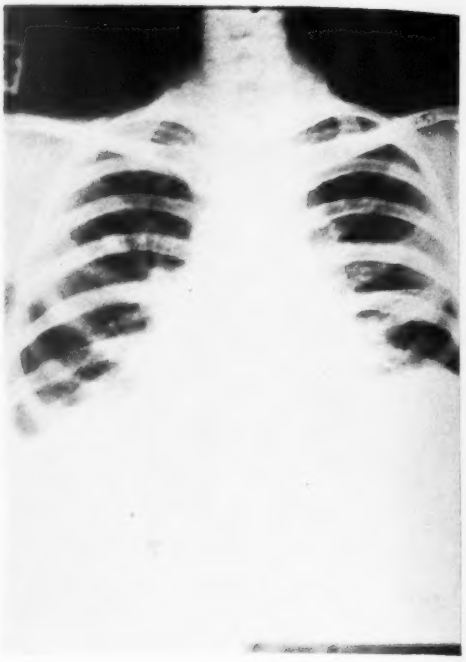

Fig. 3 (*g*). Same as Figure 3 (*f*), after aspiration of fluid.

1. of X-ray tube; in differentiating lower lobe consolidation and fluid;
2. of the patient; in pleural effusion associated with pneumothorax.

In this paper we wish to deal only with acute consolidations and their differential diagnosis. In the differential diagnosis of consolidations of the upper portion of the chest the following conditions must be considered:

1. Lobar pneumonia—upper lobe.
2. Acute caseous tuberculous pneumonia.
3. Lung abscess.
4. Localized pleural effusion confined to this region.
5. Newgrowth of the lung.
6. Chronic diffuse fibrosis.
7. Chronic infiltrative pulmonary tuberculosis.
8. Pleural thickening.

These conditions may all present somewhat similar appearances. Lobar pneumonia and acute caseous tuberculous pneumonia are often impossible to differentiate in their early stages—both present dense consolidations confined to the upper lobe, having the characteristics of lobar consolidation — sharply outlined lower border. Often a period of a week or ten days elapses before the true nature of the disease is suspected. Crisis does not occur and the consolidation persists for months, resolving only in part and nearly always with cavity formation.

Lung abscess consolidation does not present the same characteristics as lobar pneumonia. The shadow is not sharply outlined but is more rounded in appearance and has no abrupt lower margin; there is often a definite cavity seen in the midst of the consolidation. Where lung abscess results from a previous lobar pneumonia, complete resolution will not take place after

crisis, but the exudate at the periphery of the involved area will resolve and leave the remaining shadow more rounded and less abrupt.

Localized pleural effusions will very seldom give any difficulty in their differentiation from upper lobe consolidations. These usually present rounded peripheral shadows with their circular borders encroaching inward on the lung field. Occasionally, however, localized pleural effusions may present a radiographic picture identical with lobar consolidation—homogeneous shadow involving the entire upper portion of the chest, straight line lower border simulating lobar consolidation. Here the history of the case must be relied upon to surmount the difficulty. Pleural effusions of this type have been seen following lobar pneumonia and lasting eighteen months.

Newgrowths of the lung may simulate very closely lobar consolidation, however. Mediastinal tumors extending into the lung field are usually well rounded, with their base in the mediastinum, not toward the chest wall as in localized pleural effusions and tumors of the pleura.

Chronic diffuse fibrosis (cirrhosis of the lung) produces a dense but rather irregular shadow, often showing definite cavities (bronchiectatic in origin), never sharply confined to one lobe and never showing a straight line abrupt lower border. There is always accompanying evidence of scar tissue formation—this is evidenced by a decrease in the size of the chest, a narrowing of the interspaces and retraction of the trachea and mediastinal structures to the involved side.

Chronic pulmonary tuberculosis rarely causes any difficulty in its differentiation. The shadow, when consolidation has occurred, is more mottled in appearance, the result of coalescence of infiltrations, with an irregular distribution, never taking on a lobar involvement. The resolving stage of lobar pneumonia might, under certain

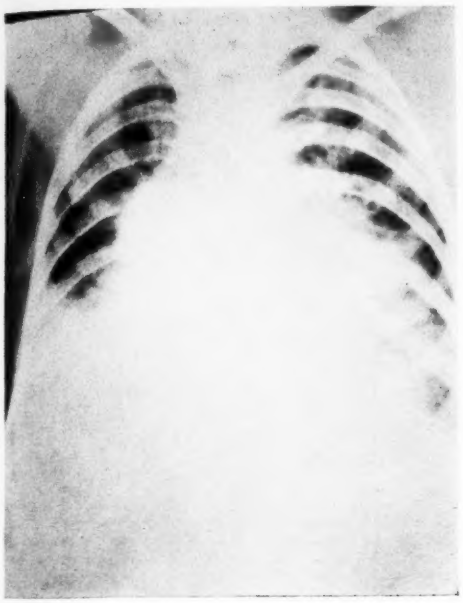

Fig. 3 (*h*). Acute consolidation of lower portion of lung, extending out from hilus region, due to Hodgkin's disease, which might readily be mistaken for beginning pneumonia.

Fig. 4 (*a*). Massive lobar pneumonia involving all lobes. Heart and mediastinal structures are not displaced.

circumstances, be confused with pulmonary tuberculosis. Any indication of a straight line lower border to the area involved would at once suggest the possibility of its inflammatory origin; re-examination after a few days would show a disappearance of the lesion.

Fig. 4 (*b*). Large pleural effusion. Note the displacement of the heart and mediastinal structures to the opposite side, from the weight of the fluid. This is quite a constant finding in children, but does not always occur in adults. When it is not present, the differentiation of fluid and consolidation becomes very difficult.

Pleural thickening of sufficient degree to cause a shadow dense enough to be confused with lobar consolidation is rarely, if ever, seen. Such a shadow would readily be differentiated, however, by the ribbon-like shadow of the thickened pleura, caught in "cross section" at the outer margin of the chest wall. This ribbon-like shadow is never encountered, even if a thickened pleura co-exists, in association with either a consolidation or fluid.

Increases in density occur in the mid-portion of the chest as a result of the following conditions:

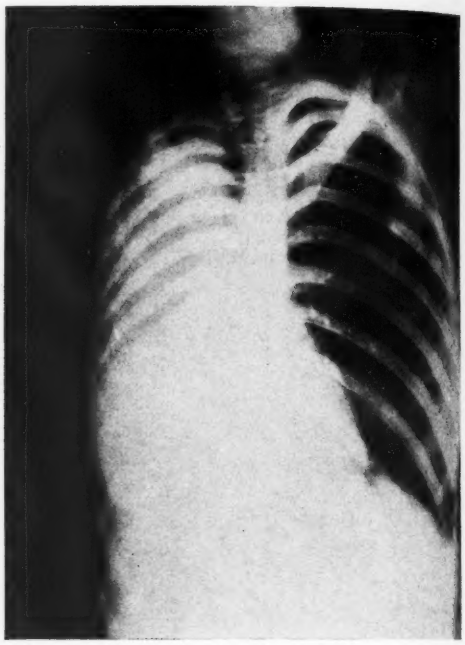

Fig. 4 (*c*). Chronic diffuse interstitial fibrosis (chronic interstitial pneumonia). Note narrowing of chest cavity, elevation of diaphragm, retraction of trachea to the affected side, and the narrowing of the interspaces—all evidences of scar tissue retraction. Bronchiectatic cavities can be seen in the consolidation.

1. Middle lobe lobar pneumonia, or lobar pneumonia of the lower portion of the upper lobe.
2. Acute caseous tuberculous pneumonia involving this region.
3. Localized interlobar pleural effusion.
4. Hilus pneumonia.
5. Lung abscess.
6. Bronchopneumonia.
7. Pulmonary tuberculosis, especially from bronchial extension of the disease already present elsewhere in the chest.
8. Newgrowths.

Middle lobe lobar pneumonia produces a relatively small shadow running across the mid-portion of the chest from the hilus region to the periphery. Its shadow has a straight line upper border and "feathers out" below into normal lung density. It differs from lobar pneumonia involving the lower portion of the upper lobe (a rare cir-

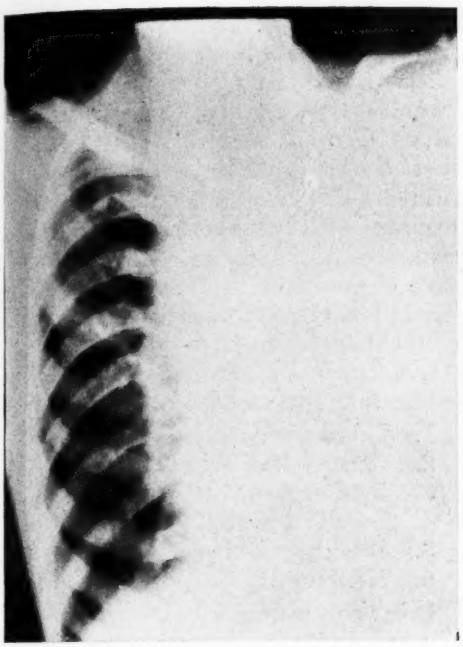

Fig. 4 (*d*). Massive consolidation from primary carcinoma of the lung, indistinguishable by plate examination alone from any other type of consolidation or fluid.

cumstance but one which is occasionally encountered in children) in that there is never a straight line lower border to middle lobe consolidations. Here, as in involvement elsewhere, lobar pneumonia often cannot be distinguished from caseous tuberculous pneumonia; time alone is the deciding factor. If one bears in mind the relative frequency of lobar pneumonia and rare occurrence of acute caseous tuberculous pneumonia (especially of the middle lobe), there should be little difficulty in coming to a correct conclusion. The differentiation from localized interlobar effusion may be a more difficult matter. Shadows from this condition traverse the chest from the hilus to the periphery, but are usually more or less sharply outlined. The shadow may "feather out" into normal lung density, however, and it may be necessary to resort to a lateral view of the chest to show the clearly outlined border. In some position, however, where a localized effusion is present, unless associated with a plastic pleurisy, there will be a sharply outlined border to the shadow. The history and clinical symptoms should be of material aid in differentiation.

Hilus pneumonia starts with a dense consolidation in the hilus region. The shadow

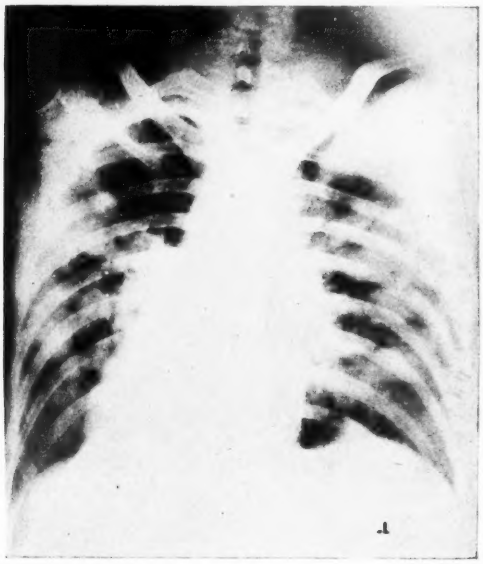

Fig. 5 (*a*). Peribronchial infiltrations involving both lower lungs, bronchopneumonia.

is as extensive within twenty-four hours after the onset as it ever becomes. In this respect it varies from lobar pneumonia, acute lung abscess, and acute caseous tuberculous pneumonia. Lobar pneumonia usually involves an entire lobe within twenty-four to forty-eight hours; similarly, caseous tuberculous pneumonia is very rapid in its spread. Acute lung abscess starts as a consolidation in the hilus region which rapidly advances toward the periphery and often shows definite evidence of lung destruction (cavity formation) in its midst, even early in the disease. The rapid spread of lobar pneumonia and the other variations in the course of the different diseases should aid in their differentiation.

Bronchopneumonia is usually bilateral and presents a distinctive picture. Irregu-

lar areas of consolidation are present in both lower lobes, resulting from the coalescence of peribronchial infiltrations. These may, under certain circumstances, be confused radiographically with secondary malignancy, but the clinical history, together

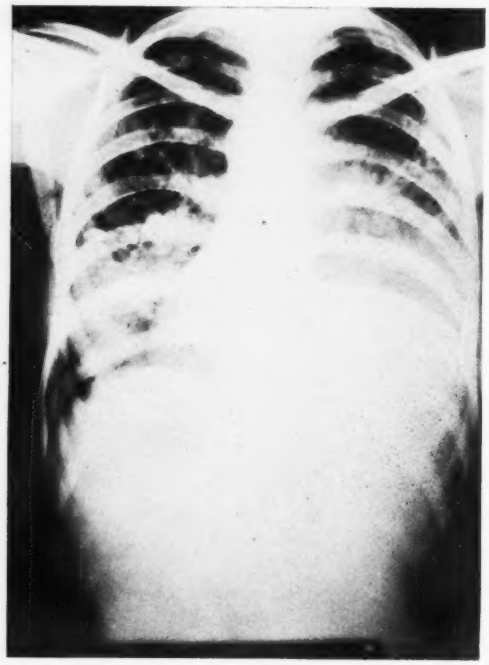

Fig. 5 (*b*). Large infiltrations of both lower lungs, resembling bronchopneumonia or even malignancy, due to a proven primary lower lobe tuberculosis.

with the fact that in malignancy the infiltrations are usually somewhat larger and more clearly defined, usually serves to differentiate the two conditions. Bronchopneumonia usually occurs in the lower portion of the lung, tuberculosis in the upper portion. This condition may be reversed, however, bronchopneumonia appearing in the upper portion of the lung, primary tuberculosis in the lower portion. Both conditions are so rare, however, that a diagnosis is impossible from a single radiograph. Not until subsequent examination indicates the course of the disease will the true nature of the condition be evident. Pulmonary tuberculosis of the mid-portion of the lung does occur, however, as a bronchial extension across the mid-line from a disease previously present in the opposite lung.

Newgrowths of the lung, especially of the secondary type, most frequently involve the hilus region and mid-portion of the lung. These cluster about the bronchi in the form of infiltrations, at times simulating bronchopneumonia. The tendency, however, is for the individual infiltrations to be larger and more clearly defined in malignancy. The history and clinical symptoms should be of great aid in making the diagnosis.

Increase in density involving the lower chest results from the following conditions:

1. Lobar pneumonia of the lower lobe.
2. Generalized pleural effusion.
3. Lung abscess.
4. Localized pleural effusion.
5. Bronchopneumonia.
6. Newgrowth.

Lobar pneumonia of the lower lobe shows a very distinctive homogeneous shadow occupying the lower three-fourths of the lung field—the costophrenic angle is the last portion of the lung to become consolidated (this point is often the deciding factor in its differentiation from pleural effusion). With large pleural effusions there is usually a displacement of the heart and mediastinal structures to the opposite side from pressure of the fluid, a condition which does not occur in consolidation. Occasionally, even with large effusions, there is no displacement of the mediastinal structures, due to a rigid mediastinum. At times, also, the costophrenic angle is not entirely obliterated by fluid—a condition most frequently encountered in hemothorax. Under such circumstances the differentiation of fluid and consolidation may be almost impossible, unless other means of differentiation are employed. If a second examination is made, taking an anterior chest plate with the tube centered high, the shadow, if produced by consolidation, will become smaller and the upper border will be more clearly outlined. If due to fluid it will remain hazy and irregularly outlined in no matter what

position the patient and tube are placed. Lung abscess may give a very similar appearance, but usually the consolidation is more rounded, representing a zone of inflammatory exudate surrounding an abscess cavity.

Localized pleural effusion, in this region as elsewhere, usually presents a homogeneous dense appearance and is located near the periphery of the chest, the sharply outlined rounded shadow extending into the lung field from the chest wall. When the localized fluid is on the anterior or posterior chest wall a lateral view of the chest may be required to show the clearly outlined border of the pocket.

Bronchopneumonia of the lower lobes may be confused with metastatic malignant infiltrations, but here, as in mid-chest involvement, the same differential points aid in recognizing the lesion.

Massive shadows involving the entire chest cavity are usually due to:

1. Large pleural effusions.
2. Massive lobar pneumonia.
3. Extensive tuberculous consolidation (chronic infiltrative).
4. Occasionally, acute caseous tuberculous pneumonia.
5. Chronic diffuse interstitial fibrosis (cirrhosis of lung).
6. Newgrowths, primary or secondary in the lung.

Pleural effusions are rarely so large that the apex of the lung becomes obliterated. On the other hand, massive lobar pneumonia causes obliteration of the costophrenic angle last, and always obscures the apex. These points, together with the other points of differentiation previously described, should aid in differentiating these conditions.

Rare cases do occur where acute caseous tuberculous pneumonia involves an entire lung in massive form, but here, as elsewhere, the course of the disease would have to serve as the deciding factor, lobar pneumonia ending by crisis and resolving within a few days, tuberculous pneumonia remaining unchanged for months and finally resulting in cavitation.

Tuberculous consolidation of the chronic infiltrative type, this extensive in character, would be irregular in appearance with evidence of cavitation in certain areas and isolated infiltrations in others.

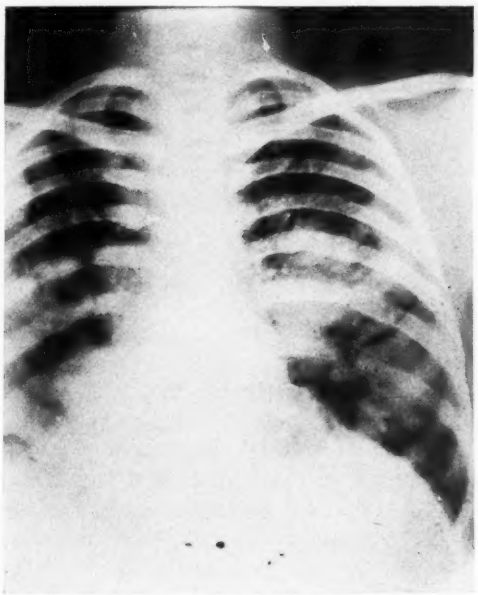

Fig. 5 (*c*). Large well-defined areas of consolidation, secondary malignancy.

Chronic diffuse fibrosis of the lungs (cirrhosis), although a rare condition, is encountered sufficiently often to require mention. The entire lung may be involved by a more or less homogeneous shadow — bronchiectatic cavities may or may not be present and the condition has a fibrosed appearance. The characteristic findings always seen in this condition are the manifestations of scar tissue formation. Massive fibrosis of the lung has resulted in organization and scar tissue formation indicated in the radiograph by narrowing of the interspaces, decrease in width of the side of the chest involved, elevation of the diaphragm and a pulling over of the trachea and heart and other mediastinal structures to the affected side. There is often a definite line of pleural thickening

along the parietal chest wall. The opposite lung is usually uninvolved. These findings are not present in other massive consolidations of the lung.

Newgrowths of the lung, especially primary newgrowths, often produce a massive appearance simulating pneumonic involvement, but the clinical history is usually all that is necessary for their differentiation from acute inflammatory lesions.

DISCUSSION

DR. I. S. TROSTLER (Chicago): In the scientific exhibit I have films of ten cases. These are cases that were selected not because they show the most marked reaction, but because they are type cases and they are mostly very early cases. In some of the pairs of films, in the first film taken there are shadows which might be interpreted as tuberculosis, but in those particular cases which I have brought, the shadows which might be interpreted as tubercular in the first film are not accentuated in the second film, but other areas are accentuated, proving that the shadow that appeared in the first film which might be interpreted as tubercular was not due to tuberculosis. My films are made so thin and the changes in the shadow are sometimes so slight that they do not lend themselves very well to reproduction on lantern slides. We tried it on a few lantern slides at the Chicago meeting, but they failed to show, and with as poor a screen as the one we have here I know they would not show, so we do not present them on the slides.

DR. A. W. CRANE (Kalamazoo, Michigan): The discussion of the papers yesterday afternoon was deferred until this time. It is not so easy to discuss a paper after this length of time because many of you will not recall very clearly what was in it. There is one point perhaps in Dr. Waring's paper that might be mentioned and that is that a great deal of stress was laid on the interference of the rib with the lung marking. I think you will all agree that in a properly exposed plate this is not a serious objection and in the stereoscopic plates of the chest this objection is entirely overcome.

Dr. Trostler gave an exceedingly interesting paper on the use of tuberculin to bring out a localized reaction in the lung sur-

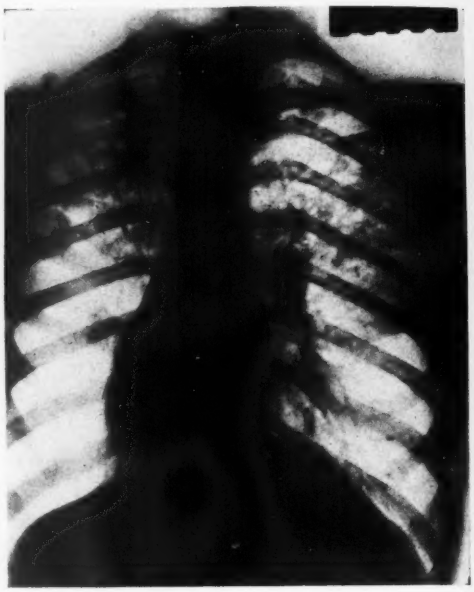

Fig. 1 (See Dr. Forney's discussion)

rounding a tuberculous focus. I have seen some attempts in that direction already; it is certainly very interesting work and opinions will have to depend entirely on actual results. Theoretically, however, we would not expect practical results from this method. We have to agree that the internists have already established the fact that the injection of tuberculin is not without danger. The original use of tuberculin after Koch's announcement, as you know, was the injection method. Later Calmette used the conjunctiva as a local measure of the sensitization of the patient; then Von Pirquet used the skin reaction, etc. These reactions depend on the sensitization of the whole patient to the toxins of the tubercle bacillus. We have the tubercle bacilli and toxins in a concentrated form in a pul-

monary focus. Why the injection of the tuberculin into the blood stream should cause a local reaction is a question that is difficult to answer. However, experimentation will have to decide that point.

I am very sorry to have missed Dr. Sante's paper at this meeting. I can recall,

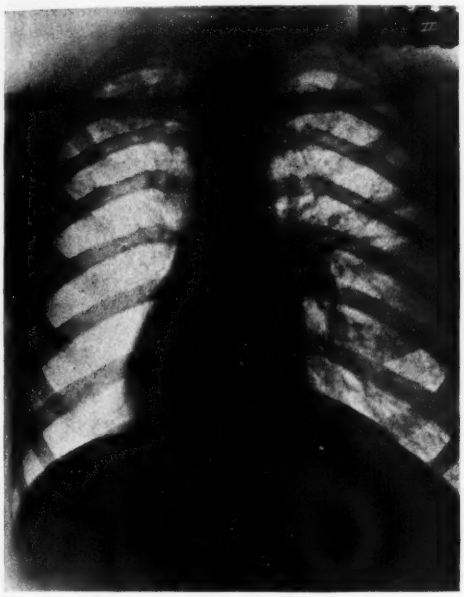

Fig. 2 (See Dr. Forney's discussion)

however, a previous paper which was extremely revolutionary, so far as my personal experience was concerned. I asked Dr. Sante, "How in the world can you accumulate so many cases of lung abscess?" I said, "I have never seen anything like it." He said, "We are doing bedside X-ray work. We examine those acute cases," and to make a long story short, the end-result was that a great many cases of so-called pneumonia were in reality abscess of the lungs. I think that is a substantial contribution to clinical medicine, and is a very forceful exposition of the fact that the roentgenologist should prepare himself to do bedside X-ray work. I presume by that means we can demonstrate many cases of so-called pneumonia to be abscess, cases which really should be in the hands of the surgeon.

I think that Dr. Stewart's paper and his exhibition of lantern slides is a most beautiful example of the necessity of a medical education in roentgenology of the chest. There is certainly no place in the vast range of X-ray work where the roentgenologist so urgently needs medical education and medical experience. The diagnosis from X-ray plates of pulmonary conditions is a process of close clinical reasoning, and you can see that the final opinion which Dr. Stewart has given is a matter of the consideration of many factors in the case and not simply of the X-ray picture.

I never attend a medical meeting without expecting to see a most wonderful wealth of rare cases exhibited by Dr. LeWald. I am sure there is nobody else in America who can, almost without preparation, throw all kinds and conditions of cases on the screen as he can. I know of nothing which can so well substitute your own personal experience as to see lantern slides of such cases. You may see only one or two of them in the course of your whole roentgenological career, but, having seen some of these slides at these meetings, you will recognize your own cases perhaps without much delay.

The subject of malignant disease of the lungs is a very important one. I want to mention one point which I presume is familiar to most of you, and that is the relationship which the X-ray has emphasized between lymphosarcoma and lymphatic or spleno-medullary leukemia. As you know, lymphosarcoma of the chest will melt down rapidly under X-ray therapeutics. In those cases treated with too much vigor, the case is transformed to spleno-medullary leukemia, from which the patient will die in ten days or two weeks. It is impossible to think of a disease changing into another—that must mean that we are observing phases of the same disease, that leukemia and lymphosarcoma are nothing but different phases of the same disease. As great a pathologist as Dr. Warthin, of the University

of Michigan, has emphasized publicly his belief that in time the leukemias, lymphosarcoma, Hodgkin's disease, and possibly multiple myeloma involving the bone marrow will be shown to be closely related.

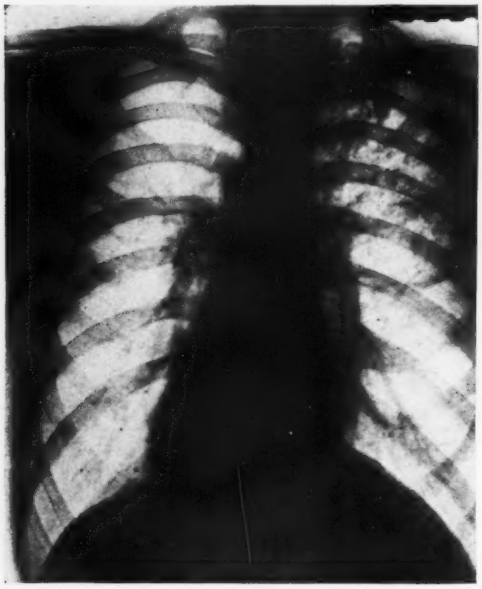

Fig. 3 (See Dr. Forney's discussion)

Miliary carcinoma of the lung brings up the question of the involvement of the lung through the blood. We can think of no method by which we can get so even a dissemination of the carcinoma through the lung except through the blood stream. The lymph flow makes it impossible for disease to disseminate itself through the lymph channels in that way and it is not an inhalation proposition. So I believe that we have in the X-ray demonstration of miliary metastatic deposits, a demonstration of blood-borne metastasis.

Dr. Fred A. Forney (Woodmen, Colorado): I would like to discuss Dr. Waring's paper as to the phase of the disappearance of the lesions in the lungs caused by pulmonary tuberculosis. He brought out that healing takes place in pulmonary tuberculosis by the disappearance of the

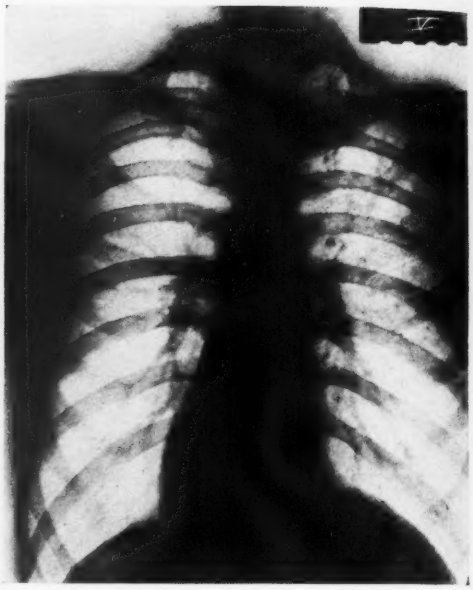

Fig. 4 (See Dr. Forney's discussion)

exudate and the shrinking of fibrosis and tubercles. I think this should be emphasized and I desire to show a few lantern slides taken of cases of pulmonary tuberculosis at the beginning and the end of their treatment.

Figure 1 shows that the patient had a cavity in the upper left, as well as fibrosis, exudate and tubercles in this same area and a few tubercles scattered through the upper lobe in the right side. Figure 2 shows the same patient, taken after approximately eleven months' treatment, during which he was a bed patient practically all the time. This shows the collapse of the walls of the cavity in the upper left, clearing of the exudate, the shrinking of the fibrosis and tubercles. The involvement on the right side has almost entirely disappeared. Figure 3 shows a rather extensive involvement in the upper and middle lobes of the right lung, classified as a moderately advanced case of pulmonary tuberculosis. This case had a period of twelve months' treatment. Figure 4 shows the extent of the clearing of the exudate and of the shrinking of the

Fig. 5 (See Dr. Forney's discussion)

fibrosis and the tubercles. Figure 5 shows evidence of the involvement in both lungs. This man was a bed patient for about six months, raising from six to eight ounces of sputum, with a slow but gradual decrease in the amount of sputum and also a slow and gradual decline of pulse and temperature. He had about eleven months' treatment. Figure 6 shows quite an extensive clearing of exudate and shrinking of the fibrosis and tubercles and disappearance of many of them. The thing of clinical importance that I see in these cases is that the two cases, one with a cavity and Figure 2, soon became free from tubercle bacilli. In the far advanced case, the tubercle bacilli were a little more persistent. The point I wish to bring out is that cases that do not have tubercle bacilli in their sputum for a long period of time are the ones that undergo resolution more thoroughly.

A MEMBER: I wish to offer three words in explanation of the distribution of fluids in the pleural cavity. Dr. Sante and Dr. Stewart both emphasized the fact of the cup-shaped upper margin of the fluid in the pleural cavity, and Dr. Stewart tells us that he has been to some trouble in demonstrating that these fluids do not change this cup-shaped margin on change of position of the patient. I think that Dr. Stewart has also

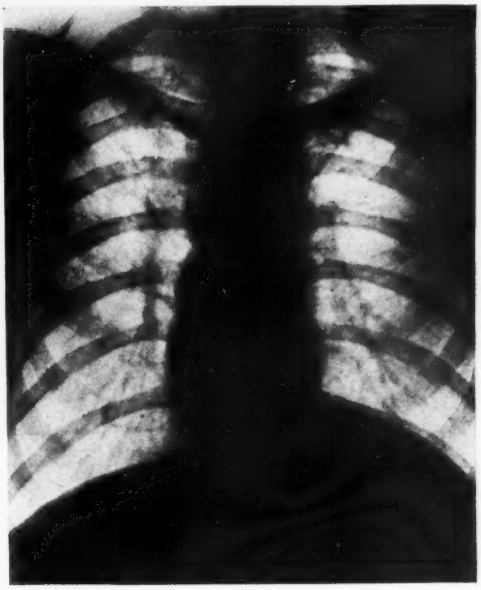

Fig. 6 (See Dr. Forney's discussion)

demonstrated to us that this is true, by the films he has shown, but I think if he could tell us that this is not only what does happen, but that this is what must happen when all the facts in the case are considered, his point would be easier to maintain. Now the distribution of fluids within the pleural cavity is a resultant complex of a number of different forces that are acting upon them, and it is a well known law in physics that bodies in motion do not obey just one law—otherwise the rifle bullet would go straight on, but it obeys the law of gravitation also, and the resulting motion is a curve, which it assumes. We, at first, are a little astonished that the fluid in the pleural cavity does not assume a level. It does not and it seems to be contrary to the laws of gravitation that it does not. It does not assume a level because it has to obey all the physical forces that act upon it and all

of the laws of physics, and not simply one of them, the law of gravitation. The reason the fluid assumes that cup shape is this: it has to obey the law of capillary attraction, which is a modification of the law of cohesion and adhesion. Now if you place in a fluid two panes of glass close together, you know that by capillary attraction the fluid goes up between the panes of glass, contrary to the laws of gravitation, as it would seem. Now, if you make those not true planes but curved a little bit, so that margin and this margin are closer together than the surface in the middle, then you will have the fluid assume a higher level on this edge and a higher level on that edge, and it will assume that cup shape that we get in the chest wall, and it is the two forces and the laws of capillary attraction between the closely approximated parietal and visceral pleura that give that cup shape. There are many other forces besides those two that act in the chest wall, such as the variation in the pressure from respiration, etc., but that cup shape is the result of these different forces acting in the chest walls and is not disregarding the laws of gravity at all. The moment you get a pneumothorax and put some air above that fluid and separate the visceral and the parietal fluids widely, then it does assume the fluid level and does move with tilting. One case Dr. Stewart showed would seem to contradict that, but it could be accounted for by the fact that adhesions had already taken place, and the fluid was imprisoned in a certain locality. The fact of adhesions and a varying air pressure in the lung has to be considered, but the two main factors are the law of gravity and the law of capillary attraction or adhesions. Dr. Crane called attention to the fact that medical education was most essential to enable the roentgenologist to arrive at a correct conclusion. I would also call attention to the fact that education along the lines of physics would help the medical man many times in explaining some things that otherwise seem inexplicable.

Dr. Frank S. Bissell (Minneapolis): It seems to me there is little more to add to the discussion of this most interesting symposium.

These consolidations or areas of increased density in the region of the hilum are most difficult to differentiate by X-ray examination alone. The history may help in the diagnosis but this is often quite as inconclusive as the X-ray findings. The differential diagnosis usually lies between an inflammatory process (abscess) and primary carcinoma.

A case in point recently came under my observation. The history suggested a chronic lung infection following an attack of influenza. Roentgenograms showed a large area of extreme density and ill-defined borders at one hilum. We thought we were dealing with a concealed lung abscess, surrounded and masked by thickened, inflammatory lung, until metastatic nodules were discovered in the scalp. The diagnosis was then changed to primary carcinoma of the lung, but there was no autopsy.

Another case in my series (see Greene's "Diagnosis," 6th Edition) showed an identical appearance but was a proven abscess.

It seems to me that we shall have gained much from this symposium if we carry away with us a knowledge that these cases cannot easily be diagnosed, but that every possible method of investigation is often required for their differentiation.

Dr. Waring (closing): After over fifteen years of study of tuberculosis from a clinical standpoint, from a pathological standpoint and from the radiological standpoint, I speak with a good deal of diffidence and cannot speak dogmatically, because the more I learn about tuberculosis the less I feel certain about what we do know. Our conceptions to-day are not what they were fifteen years ago. The science of tuberculosis has made extraordinary strides in that time, and what we think precisely to-day we did not think precisely fifteen years ago. Now I tried to point out yesterday that there was a certain amount of interference of the

bony thorax with the shadows on the plate of the chest, and I believe that that interference is very marked in the case of the flat plate and the flat plate is used by the roentgenologist very frequently in the study of chest diseases. I believe I am correct in saying that Dr. Trostler's very interesting study was made on flat plates and not on stereoscopic plates. If the stereoscopic plates are made and a shift is made up and down, if the shift is not made wide enough, the shadows you want to study—and I am speaking of the shadows of minimal lesions —will still fall on the rib shadow, and if the shift is made too far, it will fall on the shadow of the next rib, because the interspace is only about the same width as the shadow of the rib itself.

I wish to pay my tribute to the very, very beautiful scientific paper of Dr. William Snow Miller. I know that when he, after thirty years' trials to get a section which would show definitely the thing that he had conceived to be true but had failed as yet to get concrete evidence of, that when after thirty years of looking for that thing, he finally saw it, I know he must have said, "Lord, now lettest thou thy servant depart in peace." I would like to say also that I am most happy as a clinician, to have been present during the last two days to hear these papers. They have been most instructive and most valuable. I feel that many more clinicians should have been right here to-day to have had this post-graduate instruction in the study of diseases of the chest.

Dr. Trostler (closing): I have nothing to add, but I would like to urge all of the radiologists present who are associated with a lung specialist who understands the reactions of tuberculin, to at least give the method that Dr. Hayes and I presented a fair trial, so that at some future meeting we can open this subject up for complete and thorough discussion.

Dr. Stewart (closing): In answer to the Doctor's question on interlobar empyema, I would say that we have seen only a few of these cases in children. Those that have come under our observation have started at the hilus. In adults we are very liable to see the reverse.

The demonstration by Dr. Lawrence interested me very much. We are familiar with the physics of capillary attraction and it is just possible that this applies to very early effusions where the fluid climbs up between the visceral and parietal pleura, producing the ribbon-like shadow referred to in the paper. Effusion of this character, on account of scantiness, would not be liable to change its level with the change in the position of the patient. The author referred more particularly to effusions of considerable quantity in which there are *no adhesions.* Here it is not unusual to see the fluid remain absolutely at the same level when the child is placed erect, prone, lying on the side or everted; such a case was shown. This observation has been the occasion of many hours of discussion without solution. Personally, we believe it is largely due to the character of the fluid. Most of the cases in which we noted no change in the fluid level, when the position of the patient was changed, had a purulent effusion.

Dr. LeWald (closing): I would just like to mention one more condition, because in this complete symposium on this subject, it was not brought out. I refer to lesions just beneath the diaphragm, that may so confuse a differential diagnosis that we ought to bear them in mind. They are subphrenic abscess, eventration of the diaphragm, and hernia of the diaphragm.

Dr. Kahn (closing): I have nothing new to add, but I would like to call attention to the extreme rarity of finding carcinomatous metastases to the pericardium and heart.

DEPARTMENT OF RADIODONTIA

UNDER THE SUPERVISION OF BOYD S. GARDNER, D.D.S.,
ROCHESTER, MINNESOTA

ORAL X-RAY DIAGNOSIS[1]

By F. F. MOLT, D.D.S., CHICAGO, ILLINOIS

IT IS accepted that by far the greater portion of infectious foci are found above the clavicle and that these comprise practically all primary foci. These may be divided into four groups: Tonsils, sinuses, throat and pharynx, and teeth. The X-ray is of no diagnostic value in tonsil, throat or pharynx diagnosis, is of value to a degree in diagnosing involvement of the sinuses, and is of great value as a diagnostic adjunct in determining the presence and potentiality of dental foci. For when it is considered that with a full complement of teeth there are present, possibly, thirty-two separate foci, the numerical preponderance of this type of focus, and the importance, therefore, of careful diagnosis is apparent.

Rosenow's work following hard upon Hunter's excoriation of "American Dentistry," has brought about an enforced, albeit reluctant, change in attitude on the part of the dental profession toward "dead teeth." Devitalization, which had been considered heretofore an elective procedure really presenting advantages in the way of future freedom from pain, has been shown to be, on the contrary, a practice with the most menacing possibilities. Oral radiography that had been resorted to previously, principally to measure comparative success in root canal filling or to note regeneration —if any—in areas of periapical destruction after treatment procedure, now offers broader possibilities and has become a definite part of general diagnosis. That it has not come into still more universal usage may be attributed to a reactionary attitude on the part of the extremely conservative group in the dental profession, who will not concede that a "dead tooth" may be a focus of infection, or that teeth bear any relation to anything but teeth.

This attitude has thrown the burden of oral diagnosis in a great measure upon the physician, for, finding a disinclination on the part of many dentists to collaborate in detecting potential oral foci and in eliminating them when found, he has attempted to cover this field with his own. His lack of knowledge of dental conditions has been responsible in many cases for unnecessary sacrifice of teeth or for overlooking very definite sources of infection. Oral diagnosis should be achieved by teamwork between physician and dentist, each recognizing the other's problem and working for the good of the patient.

There is an all too prevalent misconception that the reading of dental radiograms constitutes a diagnosis. This is no more true of dental than of other radiograms. The radiologist is a consultant—not a diagnostician—and the radiographic evidence must first be reconciled with clinical and symptomatic findings before a diagnosis may be made.

This is where the open-minded dentist who is familiar with focal infection developments, and who will let his judgment be guided by the health needs of his patient rather than by possible lucrative restoration requirements, may bring his dental knowledge to the aid of the internist.

Much has been written on the subject of oral radiography, with rather meager results. This branch of radiography, judging by the average product encountered, has

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not kept pace with other branches in progress. This may be due to the fact that there are four sources to be reconciled: the lay laboratory, which should have no professional standing but illogically has; the medical or hospital laboratory doing general radiography—possibly also radiotherapy—and dental radiography as well; the dental X-ray laboratory, and the dentist with the toy machine doing his own radiography and diagnosis.

The radiogram being the basic factor in oral diagnosis should be as nearly perfect and complete as it is possible to make it. Many fall lamentably short of this standard. The failure may be in one or all of the following:

(1) Lack of a sufficient number of exposures to cover comprehensively all of the teeth and alveolar structures.

(2) Improper positioning or placing of films so that the teeth and other structures are distorted or overlapped.

(3) Over- or under-exposure or improper development, giving poor photographic texture, fog or lack of contrast.

Altogether too many interpretations are made of films utterly worthless and uninterpretable. It is not surprising, therefore, that errors occur, that pathologic areas are overlooked, and that hoped-for systemic results are not achieved. Such interpretations are principally guesswork.

A three to four inch penetration—no more—will give the best photographic and radiographic density. Timing should be adjusted so to expose the film that it will develop to the desired texture in five minutes at 68° F. It is assumed that fresh solutions properly mixed are to be used.

Films should be placed in the mouth with a minimum of bending and held firmly in position. The general rule that the ray be directed at a right angle to an imaginary line half way between the long axis of the tooth and that of the film is good, although the malposition of teeth and malformations of mouths make deviations necessary. With the curvature of the arch it is inadvisable to try to cover too many teeth in one exposure and the ray should be directed on the labio- or bucco-lingual axis of the central tooth in the area in order to avoid overlapping. A moderate degree of foreshortening or elongation is permissible, but never the weirdly elongated teeth that make determination of periapical conditions impossible or that throw the apices off the film entirely.

If possible, at least two views of every tooth should be shown and any doubtful teeth or area always re-exposed. All edentulous spaces should be completely portrayed as should also the retromolar maxillary and mandibular areas. The upper molar films should be so placed and the ray so directed that the malar shadow will not obscure the root ends and the relation of the root ends to the antrum floor may definitely be shown.

The determined exposure technic—penetration, target-distance and timing—that achieves a desired photographic texture in the average case should be adhered to as a standard in all cases, as it presents a diagnostic possibility in determining the comparative density or calcium content of the alveolar structures—an index of the ionic calcium throughout the body.

A complete radiogram of acceptable contrast and density having been produced, a minute examination of the films should be made, using, preferably, a shadow box that will permit of some variation in reflected light, and using also a reading glass to enlarge the image and give it depth. With a large lensed reading glass one can get practically the same appearance of perspective as with the stereoscope.

We should bear in mind primarily that there are certain anatomic deviations that should not be confused with pathologic changes. These are, namely, the radiopaque median suture and nasal spine, and the malar process in the maxilla, and the geniohyoid tubercle and retromolar inner and outer oblique processes in the mandible; the radiolucent anterior palatine foramen, the canine fossa, the antrum and the pos-

terior palatine foramen in the maxilla; the incisive fossa, the mental foramen, the inferior dental canal and the mylohyoid groove in the mandible. To these also should be added the image of the coronoid process that is frequently shown in the upper third molar region. All these deviations should be recognized and it would be well for one doing oral radiography to take a complete oral radiogram of a normal dry skull, comparing the radiographic appearance with the anatomic structures which are visible.

The nasal spine will sometimes in a degree obscure the central incisors.

The anterior palatine foramen, with its fossa, may by incorrect angulation be shown above an incisor root end instead of above and between the roots.

The canine fossa may show as a distinct radiolucence above the lateral incisor.

The antrum is frequently confused with periapical lesions of large extent, especially in cases in which excessive pneumatization has depressed the floor.

The posterior palatine foramen with a deep fossa may appear as a radiolucent area overlapping second or third molar roots.

The coronoid process shadow is often assumed to be that of a third molar root where this molar has been previously extracted.

The geniohyoid tubercle is assumed to be a root in many cases.

The incisive fossa, frequently very deep, is often taken for an extensive pathologic area.

The mental foramen may be superimposed upon a bicuspid root end and called an abscess.

The inferior dental canal and the mylohyoid groove are both often confused as pathologically destroyed areas.

Having mentally eliminated the anatomic possibilities, we come to a consideration of pathologic indications. A localized radiolucence—other than anatomic—indicates an oral source of disease, while a generalized marked radiolucence indicates a systemic derangement, as, for example, tuberculosis.

We may ignore in our search for pathologic conditions certain defects having a strictly dental aspect, as, for instance, caries, except that when a cavity is deep there is possible a septic condition of the pulp with no radiographic evidence of periapical destruction. Even an acute abscess with inflammation and swelling may show no bone destruction and be, therefore, not radiographically demonstrable.

Pathologic destruction in the mouth structures may be periapical or gingival; either manifests its beginning by a departure from normal appearance of the peridental membrane (showing as a thin black line surrounding the root) or the lamina dura (the thin white line of compact bone forming the socket and surrounding the black line), and extreme destruction is, of course, simply an increase from this inception.

Radiographic representations of granuloma, chronic perialveolar abscess or radicular cyst may not permit of differentiation but all may be considered potentially sources of infection. Granulomata and perialveolar abscesses invariably yield cultures, sometimes showing a mixed infection but always with a predominating green-producing streptococcus. The radicular cyst may contain a sterile fluid, but more often does not. The extraction of a tooth bearing a periapical mass does not necessarily eliminate the infection. This septic tissue may remain as a residually infected radiolucent mass with as definite infectious possibilities as when attached to the tooth, or, if a radicular cyst, become a true epithelial cyst enlarging through expansion and atrophy of surrounding bone.

Price tells us that in effect the pulpless tooth with or without a periapical lesion is potentially the same as far as its infectious possibilities are concerned; that the presence of periapically destroyed areas indicates only a high resistance on the part of the patient, and is no index of pathogenicity. This information, placing the radiographically negative "dead" tooth on the same

plane as that periapically involved, makes the patient's health the basis of decision rather than the radiogram, and, while permitting us to retain doubtful teeth "on parole" in cases showing no evidence of metastasis, makes the removal of *all* pulpless teeth imperative in the presence of serious systemic complications.

Roots remaining after extractions, as well as all localized radiolucent areas in the sites of extracted teeth also fall under the ban and should not be overlooked. Sclerotic bone masses are frequently very difficult to differentiate from roots. Osteogenesis may require a year, so to assume that radiolucence in an operated area indicates remaining infection if that time has not elapsed, is unwarranted; after that time justified.

Teeth may be pulpless with no periapical evidence. This condition may be due to severe trauma, to encroaching caries, thermal changes in deep filling materials, extension of pyorrhea pockets, or strangulation from the formation of pulp accretions. The mere fact of a tooth showing no canal filling is, therefore, no indication of its vitality and a routine vitality test of all teeth, either thermal or electrical, should supplement the radiographic interpretation.

For want of a more accurately descriptive term "pyorrhea" is made to apply to every degree of gingival destruction, from mild gingivitis to the purulent extreme condition in which no alveolar attachment remains. The radiograms should show soft structures in some degree to permit of radiographic determination of such destruction, and the angles of exposure should bring out all interdental spaces. As a matter of fact, however, the radiographic examination without the clinical exploration of pockets and determination of tissue hypertrophy is of little value, as the radiographic appearance of an arrested case may simulate that of one showing marked pathologic conditions.

In "pyorrhea" cases as well as in periapical lesions, the removal of infected and hypertrophied tissue is necessary. It is inadvisable to postpone operation until the bony ridge which must be depended upon for the support of dentures is practically destroyed. The probability of successful restorations is dubious in such cases.

Necessarily in this brief paper only the "high spots" have been touched upon. It would be desirable always, *if feasible*, for a trained dental consultant to pass upon dental radiograms. But the dental practitioner is often as open to criticism as is the physician in his interpretations. Radiography is a comparatively recent innovation and the entrance into practice of many dentists and physicians antedated its use. The association of teeth with systemic aberrations is likewise comparatively recent. It has been difficult to adapt these new factors to old methods of procedure, hence the impasse. The situation will be improved and all factors reconciled by more research work along dental lines, more dissemination of knowledge on this subject, and actual teamwork between the two professions.

If the inefficient lay laboratory can be eliminated; if the medical radiographer will familiarize himself in a greater degree with oral anatomic and pathologic representations; if the dental practitioner will desist from "covering up" manifest pathologic conditions under the misapprehension that to disclose their presence will reflect upon his previous work; if the average dental radiographer in company with the other two groups will improve the quality of his work and manifest a desire to make a complete survey of the mouth instead of a cursory, routine series of radiograms, too often inadequate, and if we can all achieve a unanimity of purpose that will bring about true collaboration, then not only will we put oral radiography upon a deservedly higher plane but make our diagnoses and their dependent treatment more definite, to the ultimate benefit of our patients.

RADIO-ACTIVE SUBSTANCES AND THEIR THERAPEUTIC USES AND APPLICATIONS

By JOSEPH MUIR, M.D., New York

SECONDARY RAYS

WE HAVE seen that when a gamma ray impinges upon such material as metal, it may set free from an atom of this material a secondary beta ray producing a theoretical transformation of wave radiation into corpuscular radiation. There is still but little actual knowledge of the gamma rays, for a knowledge of the wave lengths and relative intensities of the lines in the gamma ray spectrum does not carry us very far when we attempt to determine effective wave lengths, with accuracy enough to enable us to interpret the results of experiments on gamma rays. It has been ascertained that the penetrating power of the secondary beta rays practically equals that of the primary beta rays; also, if a heavy material such as lead is exposed to the gamma rays, the power of penetration exerted by the secondary beta rays is greater than when the material concerned is a less heavy element, as, for example, aluminum or brass.

SCREENAGE

Early in the therapeutic employment of radio-activity, it became evident that it was essential to select the rays applicable to the particular form of treatment desired, and to reject all others. At the beginning of this century efforts in this direction were made by such pioneers as Dominici and Wickham and Degrais, who interposed substances between the tissues to be irradiated and the source of radio-activity, which would prevent the passage of the less penetrating rays. Thus, if the alpha rays are to be excluded, a piece of aluminum one-hundredth of a millimeter in thickness will be sufficient to absorb them and prevent their further penetration; the greater part of the beta rays can be held back in the same way by a sheet of lead one millimeter in thickness. If both these metal screens should be interposed it is evident that practically pure gamma rays would pass through to the tissue to be irradiated. It might be desirable to still further increase the penetrating power of the remaining rays by filtering out the softer gamma rays, and for this purpose a sheet of brass two millimeters thick would serve.

SCREENS

This principle once established and the types of filters best suited to varying requirements having been more or less standardized by experimentation, the administration of radio-activity could be carried out with a fair degree of accuracy by the employment of filters of different thickness and density, thus applying more or less penetrating rays as the necessity of the case under treatment seemed to demand. It was found that different materials had their highest usefulness under a given set of conditions. Lead, for example, proved to be the most useful in ophthalmic work, brass served best for heavy surface filtration, while silver, which has the property of absorbing practically all the beta rays—only the very hardest being able to penetrate it—as well as many of the softer gamma rays, proved to be the best substance for general use, both for the element and emanation. Platinum has found a usefulness in all the situations where other metals could be suitably employed because as the filtration power of one millimeter of platinum is almost equal to one millimeter of lead, and that of 0.5 millimeter of platinum equal to that of two millimeters of brass, the substitution of platinum for these less precious metals makes it possible to use a smaller bulk of filter, which, especially when needles are being employed, is often a matter of considerable moment.

EMANATION TUBES

As knowledge of the therapeutic properties of radium increased it was discovered that the active deposit of the element possessed them quite as much as the element radium itself. More than that, it was established that if the element were enclosed in a container, the rays given off from that container were not the direct product of the radium itself, but from the collection of active deposit which was going on within the container. It thus early became evident that radium therapy could be administered much more easily and satisfactorily if the emanation and its active deposit could be used instead of the actual radium element, for they could be placed in a container of any desired size or shape, molded to fit any cavity of the body, or made suitable for any location. Many other advantages immediately suggest themselves, which have been succinctly enumerated as follows:

(*a*) The emanation may be put into containers of any desired shape, size and strength, which permits a flexibility impossible when radium salts are used.

(*b*) Sources of radiation of small size and great intensity can be constructed when radium emanation is used, for the volume of this emanation is most minute when compared with the amount of radium element which would be required in order to produce an equal intensity of radiation.

(*c*) Small tubes originally containing small amounts of radium emanation can be left in neoplasms for an indefinite length of time, the patients being able to carry the tubes away with them. For this purpose tubes which were originally of high concentration, but have decreased in value by disintegration, may be employed. Such ambulatory treatment would be quite out of the question if the radium salt were being used.

(*d*) As compared with the mass of radium element necessary to produce a given power of radiation, the mass of radium emanation required to produce the same effect is very much less. As the radium emanation absorbs but little of its own rays, when used under certain conditions it is capable of producing a much more intense radiation than could be obtained from the radium element from which it was originally derived.

(*e*) Tubes or applicators containing radium emanation may be shipped from central stations for reasonable distances without the danger of a great material loss.

THE COLLECTION OF RADIUM EMANATION

The method of radium emanation collection which is in general use to-day—essentially the same as that employed by Ramsay and Rutherford in England and Duane in this country—is as follows: Any chemical or physical change is known to be accompanied by a corresponding change in the element of heat, though some changes may be exo-thermic, that is, giving off heat, while others may be endo-thermic, absorbing heat to complete the reaction. Radio-active changes are accompanied by exo-thermic changes, that is, outward liberation of heat. As a gram of radium produces about 133 calories or heat units per hour, it will, in its average life, dissipate about the same amount of energy as would be liberated by the combustion of one million tons of coal. The experimental values of the radiations from radium emanation are thus proportioned among the different types of rays:

Alpha	91.9 per cent
Beta	3.19 per cent
Gamma	4.84 per cent

It is known that radium is constantly producing radium emanation, but that this emanation is only liberated freely in the presence of heat, or when the salt is in solution. It has been found that, in common with other gases, radium emanation goes into solution when brought into contact with liquids, the amount absorbed by any particular liquid being in proportion to the pressure of the emanation, in accordance with the law pointed out by Henry.

The emanation is obtained from radium —most commonly in the form of a bromide —by making a solution with water to which hydrochloric acid is added in the collection

apparatus. The emanation liberated from the solution is allowed to accumulate in a flask provided for that purpose in connection with the apparatus, from which it is pumped off at stated intervals. These intervals depend somewhat upon the milligram content of the radium in solution, but ordinarily are about twenty-four hours in length. The radium emanation, together with the other gases given off by the solution—helium, aqueous vapor, hydrogen chloride and bromide—are now transferred to a purification chamber, using a simple Templer mercury pump. In the purification chamber the extraneous gases are eliminated, and the radium emanation is again transferred to the receptacles in which it is proposed to put it to therapeutic use. When the radium emanation has been for three hours in these containers it has developed its maximum amount of radiation.

"SEEDS"

When radium emanation "seeds" are desired the receptacle in which the final product of collection is placed is a fine capillary tube about one meter in length. Using a small Bunsen gas flame the tube is sealed in brief segments, so that they may later be bisected into "seeds" three to four millimeters in length. The intensity of the radiation begins to decrease after the three-hour period has ended, and after 3.85 days the intensity of this radiation will be found to have decreased to one-half of its maximum value. While the necessity of allowing for this decrease in value somewhat complicates the calculation of dosage, on the other hand in certain methods of treatment it really adds to the value of the radium emanation as a therapeutic agent. For example, small amounts of radium emanation may be inserted into cancer tissue and left there for an indefinite period, for, as the decay period of the radium emanation can be definitely reckoned, it is known in advance exactly how much radiation the patient is to receive, both as to the number of days and the intensity of the dose. It is possible to use tubes of different sizes containing different amounts of radium emanation; thus, a single strong tube may be used alone, or a number of weaker tubes may be spread over an extended surface, according to the nature of the lesion which is to be irradiated.

It is customary to estimate the amount of radium emanation contained in a given tube and express it in terms of a unit which has been designated as a *millicurie*. Millicurie may be defined as the maximum quantity of radium emanation which can be accumulated in a sealed tube in which one milligram of radium element has been placed. The amount contained in an applicator may vary all the way from a fractional part of one millicurie up to several hundred.

DOSAGE

The amount of radium emanation to be applied and the manner in which it is to be distributed through a given lesion, cannot be governed by any fixed rule. If a tumor, for example, is very large the amount of radium emanation to be contained in each tube as well as the number of tubes to be used, and the number of millicurie hours during which they are to be applied, all will be larger than would be the case in treating a small growth, yet the increase is not proportional to the size of the tumor. Factors other than size influence the length and size of the applications. Relatively heavier doses per cubic centimeter must be used in neoplastic growths which cover large areas but do not penetrate deeply, than are required in spherical growths of greater penetration. A widely extended epithelioma will, therefore, require practically the same dosage as a deep-seated growth having a diameter as long as the greatest extent of its surface.

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EDITORIAL

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WILHELM CONRAD ROENTGEN

His Life and Work

By I. SETH HIRSCH, M.D., New York City

(Continued from page 142)

The scientific labors of Roentgen may be divided into four periods:

Between the ages of 25 and 34 (1870–1879), in Strassburg (10 years): 15 publications.

Between the ages of 34 and 43 (1879–1888), in Giessen (10 years): 18 publications.

Between the ages of 43 and 54 (1888–1900), in Würzburg (12 years): 17 publications.

Between the ages of 54 and 74 (1900–1920), Munich (21 years): 5 publications.

In all, he published fifty-nine more or less extensive treatises (including the address on the life of his predecessor, Professor Kohlrausch, and the "History of the Contributions to Physics by the University of Würzburg") which, before the discovery of the X-rays, related to technical aids to experimental work, to the problems of electric discharges, to the changes in the character of substances under change of pressure, and to the study of crystals.

The latter researches involved problems which were greatly to his liking. From the very beginning of his scientific career until the end, the crystals seemed to fascinate him and again and again he returned to the problems they suggested, devoting to the subject much scientific study and thought. Almost his last piece of work related to the influence of the X-rays on the electric conductivity of crystals.

Was it some uncanny intuition, a sort of divination, or a true prophetic vision which drew him again and again to the study of the crystal? Did he foresee the remarkable truths which they were to disclose? Did he suspect that these very crystals would provide the key by which many of the darkest secrets of Nature might be unlocked?

As an evidence of his amazing foresight, it is to be noted that in his experiments to determine the possibility of the reflection of the X-rays, he used mica as a material for his experiments, for he apparently appreciated that a piece of mica would influence the X-rays differently than would glass. Why his experiments did not succeed is apparent. Twenty years later Frederich and Kipping's solution of this problem, based on a suggestion of Laue's, greatly interested him and he encouraged it by advice and assistance. After all, his intuition regarding the crystal had been justified.

His researches also covered the examination of the specific heat of gases, the study of isothermal crystals, solar calorimetry, dust figures, the size of the molecule, the compressibility of water, the absorption of heat by vapor, the influence of pressure on the various characteristics of substances, pyroelectricity, piezoelectricity, the electromagnetic effect on the polarization of light in gases, the electrodynamic power produced by the motion of a dielectric in a homogeneous electric field, called the Roentgen current and characterized by eminent physicists as a greater discovery from a theoretical standpoint than the X-ray.

He had been studying the effects of high pressure on the physical, chemical, electric and magnetic properties of substances—

and then followed his work with the vacuum tubes and the discovery of the ray. He now issued the famous three papers on "A New Kind of Rays," which he called "X-rays." These papers illustrate strikingly the characteristics of Roentgen's scientific work. What marvelous foresight he showed in these papers! What genius, what skill in planning his experiments! It is well known that he had his principal results months before he published them. His disinclination to publish his work prematurely sprang from the desire to study the problem in its minutest detail, allowing the work to slowly ripen to completion. So thoroughly were the characteristics of this radiation described (the effect on fluorescent substances, on the photographic plate, the dispersion, the non-deviability by magnetic fields, the origin of secondary rays, the varying absorption by different bodies, the ionization of the air, the hardening of the rays with absorption, etc.) that in spite of the extraordinary activity of physical research which followed, nothing of any importance was discovered for ten years following.

Though before the discovery of the X-rays, he had published almost fifty papers in a period of twenty-five years of scientific activity, for ten years following the discovery he issued no publication, though he showed an intense interest in all research which concerned itself with the nature and characteristics of the radiation. Though he did not again take up the subject, he freely discussed and criticized the researches of his pupils.

It would seem that, after all, he was concerned with a great and fundamental problem, the ultimate constitution of matter. He searched for it fruitlessly in the changes which matter undergoes under high pressure and found it in the changes which matter undergoes at low pressure—in that "fourth state of matter," the radiant energy of Crookes,—in that truly dark space in the vacuum tube. His was the exemplary scientific mind rising steadily from insight to insight, in the search for the ultimate truth.

INVESTIGATOR

In the consideration of Roentgen's scientific labors one characteristic that stands out above all others is the self-restraint shown in his intellectual activities and his reverence for temperate and accurate deduction. His schooling was one in thoroughness, exactness and precision. Indeed, as a keen, inductive thinker, he had no peer in the modern scientific world. Nowhere in any of his productions is there a hasty conclusion based on insufficient premises, nowhere any unfounded generalization. It is always the careful, painstaking work of an investigator, who constantly denies himself the joys of enthusiasm, persistently represses his emotionalism and the tendency to glorification in his achievement. The constant self-questioning, the c o n s t a n t searching analysis of his own beliefs and observations, indicate a mental asceticism which characterizes the highest type of scientific worker. He permits the facts to speak for him. His experiments, therefore, have an elemental firmness, strength and finality. It is the quality and not the quantity that renders his work of such surpassing value.

He is the classical scholar of Ostwald's classification, who works out the problem to the minutest detail and to such a state of completeness that nothing can ever be added to it or subtracted from it.

Although Roentgen was a practical, experimental physicist, his work nevertheless reveals him as a master of theory, keeping pace with this aspect of the most difficult problems, by virtue of his extraordinary experimental gifts.

Like the great Faraday, he was no mathematician, and the mathematical side of the theory interested him but little, though he did not underestimate its value. His aim was always, however, to make the theory understandable by and accessible to experimental research. He had a keen sense for the recognition of a problem, the

great gift of experimental skill for examining it, and the power of searching criticism as to the probable sources of error and their influence upon the results. It was these three important characteristics which gave the results of his researches their enduring value.

The subjects he chose for his work were always those in which precision was essential. And with great scientific courage he undertook problems the solution of which was fraught with the utmost difficulty. To him scientific research was a war against Nature,—defending her secrets with every means at her disposal, and rarely giving anything freely. As did Prometheus, so the fire must be torn from the gods, even at a great personal sacrifice. He was the exponent of science for science's sake, disregarding all material considerations. He said he could concern himself only with those problems in which he had a deep personal interest, and it was either this or nothing. He hated restrictions. The true spirit of research could exist only through the free play of the imagination. He could not interest himself in problems whose aim was only technical profit. Though from the very beginning Roentgen realized the great importance of his discovery from the standpoint of its practical application, he nevertheless refrained from any direct participation in the rapidly developing technic of its use. Thus he really made a great contribution to the development of the subject, by his refusal to profit materially by his discovery, or to place any restriction whatever on its use. He might have patented the principle of the use of the anticathode, but he desired no material compensation. He had his compensation in the joy of the free disinterested search for truth, in the happiness it brings to one who has disclosed it, in the independence of spirit which it confers on one who has served it, in the deep sense of responsibility it develops. His was the joy of accomplishment—of having given to humanity a beneficent agent, a new light, indeed, by which to seek out the secrets of Nature.

He said that "Science enforces a certain state of resignation upon the investigator, because it is almost certain that sooner or later his work will be surpassed by others and that both the memory of the man and his work will gradually be forgotten."

This is a thought quite in harmony with his modesty and the spirit of service which inspired all his efforts. It was, indeed, a remarkably appropriate stroke of Fate which placed the great epoch-making discovery in his hands. And yet it is not at all strange. Behind him lay twenty-five years of preparation, a schooling in accuracy of observation, a schooling in clear thinking, a schooling in searching analysis and logical deduction.

A striking characteristic of his scientific work was his marked versatility. He frequently changed the subject of his research. The bridge to this versatility was his encyclopedic knowledge of the literature. He was an omnivorous reader and every aspect of physics interested him, even subjects with which he had no experimental experience. He spent a great deal of time with his journals and references, reading often very late into the night, and on his journeys to and from his country home at Wielheim, at the foot of the Bavarian mountains.

TEACHER

As a teacher he showed an extraordinary aptitude and it was his thoroughness which drew to him many students. He hated superficial, theoretic, incomplete instruction, and never compromised for the gain of popularity. He never sought to mask the difficulties of a subject. He sounded the very depths of a problem and sought to give it simplicity and clarity. The experiments in his lectures were carried out with the utmost care and the greatest accuracy. The new students yawned at his lectures because of their thoroughness and detail, but to those who had a knowledge of

physics they were rich in content and suggestion.

Though always ready with advice and assistance he never forced it on a student, coming to his aid only when the student turned to him in his perplexity. He did not believe in pampering students. He knew the value of self-reliance, the gain which comes from unaided accomplishment. He was truly, as has been said of another great scientist, "a mid-wife of minds." Because of his great analytical power, his assistants and students were anxious for his criticism of their views and the arrangement of their experiments, and with marvelous accuracy he delved directly into the heart of the problem and recognized at a glance where the sources of its error lay, and with the patience of Job he would elucidate his ideas until the merest tyro was completely convinced.

He continually impressed his pupils with the necessity of controlling their results by an examination of the problem from many angles, warned them against indefiniteness in hypotheses, adjured them to keep strictly to experimental facts. Speculation in physics, he urged, should play only a preliminary part in the consideration of the problem, but the truth must be established even if a ruthless destruction of carefully elaborated hypothesis was necessary.

He acknowledged the great gain, even to the investigator, from the experiences of teaching. It necessitated a continual renewal of ideas and kept the mind abreast with the advances of science.

PERSONALITY

The predominating characteristic of Roentgen's personality was a rugged honesty and a passionate devotion to the truth, coupled with a great simplicity, and an almost shrinking modesty. The honors and acclamations of the world in no way affected the modest character of the man. Only when some new application of the rays was indicated to him did a glow of happiness and pride come into his eyes, at the thought that he had been instrumental in giving such a thing to the world. Yet he avoided attendance at the numerous celebrations in his honor. The older he grew, the more praise the world bestowed on him, the more he retired from publicity, much to the regret of the physical world; and thus he remained almost unknown to the enlarging circle of younger men.

There was a certain reserve in his intercourse with strangers, a certain reticence amounting almost to personal shyness. Behind his cold, austere, impressive exterior there glowed, however, a warm sympathy and friendliness. He was quick to recognize breeding, character and ability. He made but few friends, and these without exception held to him through life. In personal intercourse he desired, above all things, clarity and frankness of expression and despised ambiguity and hypocrisy.

Though he was not a man of great sociability and did not inspire familiarity, he nevertheless had no desire to be considered unapproachable, maintaining towards his assistants and pupils an attitude which permitted easy access. He would frequently invite his students to accompany him in his walking and hunting trips at his country home in Wielheim, but in the face of this intimacy they had for him almost a religious reverence.

He had a mania for orderliness, having probably derived this quality from his Dutch mother. All his instruments and apparatus had to be in perfect order and ready for use, particularly the measuring devices. These were to him more than personal belongings. They were his children. He guarded them zealously and bestowed upon them endless care and attention. "Apparatus," he was wont to say, "are cleverer than men and anyone who mishandles apparatus is my enemy."

The secrecy which he maintained regarding his method of performing his experiments sprang not from any desire of shrouding his experimental technic in mystery but from a sincere modesty

Usually he worked alone, taking an assistant now and then only for the arrangement of his instruments or, because of his color-blindness, for the reading of color data.

There were some petty minds that could not understand the sudden appearance of so bright a star in the firmament, and Roentgen did not escape the calumny and the slander of the envious. In Würzburg the discovery was imputed to the old laboratory attendant, Marstaller, and in Munich to a technical assistant named Weber, who actually met Roentgen for the first time five years after the discovery. These stories, so ludicrous to those who knew the working methods of Roentgen, were nevertheless seriously supported even by some physicists who sought to minimize the scientific attainments of Roentgen, and to influence public opinion to believe that the discovery was only the result of a favorable accident.

His refusal to answer these slanders but intensified the vituperation which followed him, even in Munich, and reached the height of its fury in an attack, remarkable for its malice, in a Munich newspaper. So bitter and unjustified was this attack that his friends and pupils rallied to his support.

"It is akin to a great misfortune," said his pupil, Wagner, "to have made such a discovery." But Roentgen bore these attacks of his enemies with imperturbable serenity and maintained a stony silence, allowing the facts to speak for him.

After all, there are incidents of similar character in the life of every man who has given anything to the world. The forces of reaction, the forces of envy, vent their malice on those who proclaim the truth, and whether it is Galileo, Semmelwise, Columbus, Roentgen or Einstein, the reaction is always the same—it is the penalty of greatness.

. . . . . .

Considering the originality of his work—the simplicity and finality of the solutions of the problems with which he concerned himself, it might appear that they were in the nature of happy discoveries, easily accomplished, and without effort—by a sort of divination. But it was the force of exact, painstaking investigation, of a highly trained, courageous and stubborn personality, modest in his great strength, constant and inflexible in his purpose, coupled with a clarity of vision and directness of purpose which carried him to the high summit he attained.

What are the lessons to be derived from his life?

To serve the truth passionately, devotedly, courageously, and to have faith in its ultimate triumph; to be free, to be simple, to be modest and to look beyond selfish interest in the labor one has chosen to perform.

We are too near the age to obtain the proper perspective on the personalities which will dignify it, but from the distance of centuries Wilhelm Conrad Roentgen will be seen as one of the towering figures of our time.

THE END

THE PATTERSON SCREEN COMPANY ACQUIRES SCREEN BUSINESS OF DR. H. THRELKELD-EDWARDS

The Patterson Screen Company, of Towanda, Pa., manufacturers of Patterson Cleanable Intensifying Screens and Patterson Fluoroscopic Screens, has absorbed the business of the late Dr. H. Threlkeld-Edwards, who was well known to the medical profession as the pioneer maker of X-ray screens of the United States.

Although its own screens are widely used by roentgenologists, the Patterson Screen Company has no intention of discontinuing the manufacture of Edwards screens. As a scientific organization it realizes that a number of roentgenologists have developed their technic with the T-E screen, and it will therefore continue to produce T-E screens in exact accordance with the formulas and principles of Dr. Edwards.

The combination of the Patterson and Edwards interests will make it possible for a single company to make and sell X-ray

screens and thus to reduce production and merchandising expenses. The saving thus effected will be passed on to the medical profession in substantially reduced prices for both Patterson and Edwards screens.

The Patterson Screen Company has conducted valuable research work for the improvement of X-ray screens. It will continue its research policy, so that the technical demands of roentgenologists will be met, so far as screens are concerned. In addition, it will place its knowledge and experience at the disposal of roentgenologists without charge.

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Spondylitis.—In nineteen cases there were definite clinical evidences of spondylitis. In fourteen of these there were positive roentgenograms, and twelve of the fourteen showed pathologic changes only in the lower lumbar region (third to fifth). These changes were hypertrophic in all twelve, and in eight of the twelve there was also partial or complete destruction of a disk in the same region. These facts, together with the histories, especially when the ages of the patients, the time and nature of the onset, and the course of a subacute arthritis of the spine are considered, seem to the writer to form a fairly definite picture, differing from that of other types of infectious spondylitis and pointing to the meningococcus as the causative organism. Since spinal joints are susceptible to practically all the other varieties of arthritis found in other joints, there appears to be no reason why the spine should be immune to the meningococcus. Moreover, the spinal puncture needle may easily afford a direct means of inoculating the lower lumbar vertebræ and disks with the meningococcus, and, in view of the location of the pathologic conditions in the cases recorded, it appears very probable that it is an important etiologic factor. The two cases in which there were pathologic changes in other regions may represent metastatic infections, such as occur in the involvement of joints of the extremities, though apparently less frequently. Treatment should be early and prolonged immobilization.

W. W. WASSON, M.D.

Spondylitis Following Cerebro-spinal Meningitis. R. Wallace Billington. Jour. A. M. A., Aug. 30, 1924, p. 683.

Radiation in dermatology.—In the human skin, the cells of the germinal layer, hair papillæ, the sebaceous and sweat glands, the endothelial cells of blood vessels and fixed connective tissue cells are radio-sensitive, while the non-nucleated elements, as the hair, elastic and collagenous connective tissue, are only slightly sensitive. The therapeutic effects are explainable through inhibitory effects on cell division.

By accurate filtration, the effects of either beta or gamma radiation may be utilized; for superficial action on the skin beta rays exert the chief effects, and when gamma radiation is desired, the destructive activity of beta rays should be eliminated by screening. Of the benign tumors of the skin, the following are at present recognized as the most important: keloids, vascular and pigmented nevi, lymphangiomata, benign cystic epitheliomata, synovial cysts and rhinoscleroma.

There is a group of diseases classed as inflammatory and of uncertain etiology which are symptomatically healed by radium; among these are lupus erythematosus, psoriasis, chronic eczema and lichen planus.

Among the superficial hypertrophies of the skin curable by radium are keratosis senilis, verrucæ, callosities and sometimes clavi.

For successful use of radium therapy on the skin, it is essential that one be trained as a dermatologist and also trained in the technic of radium application.

W. W. WATKINS, M.D.

Radium in the Treatment of Non-malignant Diseases of the Skin. Frederick S. Burns. Boston Med. and Surg. Jour., July 3, 1924, p. 16.

Tuberculosis of the knee.—In suspected cases of tuberculosis of the knee, that is, those in which the circumstantial evidence points definitely to tuberculosis as the disease process, operation should be performed for the purpose of establishing a positive diagnosis. Tissue should be examined and animal inoculation done. This course is justifiable because the disease process, where it exists, will more or less completely destroy the knee, and will act as a menace to the life and limb of the person dis-

eased. A Wassermann test should be a routine procedure in the study of the etiology of knee-joint disease.

In case the tissue examination by the microscope shows no evidence of tuberculosis, or in case the guinea-pig inoculation shows, after a proper period of time, no evidence of tuberculosis, then it may be safely assumed that the knee joint in question is free of tuberculosis. For a person to have syphilis as well as knee-joint tuberculosis is perhaps more frequent than is generally realized. It is essential for those who attempt to estimate the value of therapeutic measures, such as heliotherapy, to establish a positive diagnosis of bone or joint tuberculosis in all cases included in their statistics.

W. W. WASSON, M.D.

Tuberculosis of the Knee. Nathaniel Allison. Jour. A. M. A., Sept. 6, 1924, p. 750.

Mouth lesions.—The majority of patients with malignancy in the mouth die of metastases. Therefore, the treatment of these metastases is an absolutely essential part of any plan of treatment. The presence of cervical metastases at the time the patient presents himself may call for intensive treatment, but in all cases sufficient treatment should be given to destroy malignancy whether it is demonstrable or not. It is only in this manner that the chances for permanent recovery may be improved. If the neck is not treated until metastases are palpable, the case becomes a serious one and the possibility of a complete cure doubtful. The author's experience with cervical metastases is summed up as follows: Radium treatment externally has given no different results than roentgen radiation with 9-inch back-up. Radium needles buried in large cervical masses through the skin have not produced any cures. Removal of large masses and burial of radium in the wound has been ineffective. Recurrences after surgical removal have, as a rule, been entirely unaffected by radiation. High voltage roentgen therapy has given somewhat better results than any of the above methods, at least in so far as the disappearance of palpable manifestations of disease is concerned. Not all cases respond alike to this treatment and some are practically unaffected. In order to lessen the likelihood of cervical metastases, intensive radiation of the neck is given before the primary lesion is touched. The author used the so-called deep therapy technic, applying an erythema dose at one sitting. If palpable masses are present, the dose is repeated in six weeks and as often thereafter as possible until the glands disappear. If no enlarged glands are present, the dose is repeated in eight weeks.

Technic plays a more important part in mouth lesions than in any other location. If the lesion is underdosed, it has progressed to an incurable stage by the time the dose is repeated. Repeated small doses are known to render the disease insensible to further radiation, even if massive doses are resorted to. On the other hand, overdosage, at least by the method of introducing needles, causes extensive sloughing and the patient may die with the lesion still in that state.

J. D. CAMP, M.D.

The Treatment of Malignant Diseases in the Mouth. G. W. Grier. Am. Jour. Roentgenol. and Rad. Ther., Oct., 1924, p. 347.

Leukoplakia of the renal pelvis.—Two new cases of leukoplakia of the renal pelvis are reported. Leukoplakia of the urinary tract, and particularly of the renal pelvis, is relatively rare, only 33 cases (including the writer's own) having been reported in the renal pelvis.

Leukoplakia of the urinary tract may be defined as an epidermoid transformation of the mucosa, in plaques usually, with excessive keratinization and desquamation. The condition is generally associated with long-standing inflammation, calculus formation or other irritation, which seem to be contributory factors in its causation.

The etiology of leukoplakia is unknown. The most common theories are that it is (1) a true metaplasia on the basis of chronic inflammation and irritation, or the biological process of adaptation to environment in the form of protective cornification; or (2) that leukoplakia of the urinary tract arises on the basis of misplaced embryonal rests of primitive ectoderm.

Leukoplakia of the renal pelvis occurs with about equal frequency in the sexes. It may occur at any age, the greatest frequency, however, being in the fourth decade.

The symptomatology is that of urinary tract infection (cystitis, pyelitis, pyelonephritis, pyonephrosis) and urinary lithiasis, conditions with which it is usually associated.

The treatment of choice is nephrectomy, since the disease is incurable and precancerous. Palliative measures, in the form of pelvic lavage, are probably beneficial only in subduing infection and in that way possibly delaying the progress of the condition. The value of radiotherapy is not known. Fulguration may be of value in leukoplakia of the bladder, but as yet no reports of its use have been found.

W. W. WASSON, M.D.

Leukoplakia of the Kidney Pelvis. Frank Hinman, Adolph A. Kutzmann, and Thomas E. Gibson. Surg., Gynec. and Obst., Oct., 1924, p. 472.

Resuscitation methods.—We witness to-day the presentation to the public of many strange and some very ingenious suggestions for resuscitation. When we have given all these methods a competent analysis, we are reduced to the selection of the prone pressure method of resuscitation as our great reliance for immediate emergency, and we turn to the oxygen-carbon dioxid inhalation method devised by Henderson and Haggard as the physiologic antidote for carbon monoxid asphyxia, and through simple inhalation apparatus practically allow the patient to administer this mixture to himself. It is conceivable that physiologists may some day devise a positive pressure artificial respiration apparatus which, even in comparatively unskilled hands, can be relied on to ventilate the lungs. Our examination of such devices as are now on the market has failed to disclose any that prove to be of value.

W. W. Wasson, M.D.

Artificial Respiration in Electric Shock and Gas Poisoning. C. K. Drinker. Jour. A. M. A., Sept. 6, 1924, p. 764.

Tuberculous cavities in infants.—Ordinarily tuberculous cavities in infants present no physical signs by which they can be recognized, and it is only by the roentgenogram that an antemortem diagnosis of ulceration can be made. The location of the cavities occurring in the first period of childhood is removed from the apices, as a rule, in contrast to this region as the most frequent site for cavity formation in adults. The usual site is in the middle or lower lobes, centrally located or near the lung roots. The right lung is more frequently involved. As a rule, ulceration is largely confined to one lobe, or to one side of the chest.

The author reports seven cases of ulcerative pulmonary tuberculosis, observed in children under two years of age. There were six males and one female. Six out of the seven cases were colored babies. It is believed that the larger number of negroes developing cavities is due to the well-known fact that the colored race is more susceptible to tuberculosis and has less immunity against the disease than the white race. The youngest in the series was six months and the oldest twenty-four months. The intradermal tuberculin test was positive in all. There was not a single instance of hemoptysis, although three of the cavities were of such size as to occupy an entire lobe or more. Three out of the seven developed meningitis.

The presence of a widened mediastinal shadow and enlarged hilum shadows consistent with tuberculous adenitis are roentgen evidence in favor of pulmonary tuberculosis. The failure of a pneumonic process to clear up in the usual time may be the first indication of tuberculosis.

J. D. Camp, M.D.

Ulcerative Pulmonary Tuberculosis in Infants. H. L. Farmer. Am. Jour. Roentgenol. and Rad. Ther., Oct., 1924, p. 327.

Ovarian implantation.—Following implantation, then, there is usually a fairly normal menstruation, a return to good health and a gain in weight, but there may be nervousness and some discomfort, such as backache, headache or pain with the menses, in or about the implanted ovary. Rarely, the ovary may become cystic and require subsequent removal. Pregnancy may occur. If pregnancy takes place, it is because the opening in the uterine horn is brought in contact with a point on the cut surface of the ovary where a graafian follicle will develop. Factors that influence the successful extrusion of the ovum into the uterine horn and cavity are: (1) patency of the uterine horn, and (2) the proper development of a graafian follicle.

1. The inflammation of the tube, or the trauma of operation, may involve the horn or its mucous membrane so that in healing it is closed. This possibility must always be reckoned with as a cause for failure of pregnancy and may be obviated by a deeper section through the uterus, reaching the beginning of the uterine cavity itself.

2. The ovum or ovum-bearing tissue, the cortex of the ovary, may not be brought in contact with the mucous membrane opening of the uterine horn. This may more surely be accomplished by care in sectioning the ovary so that a bare shell of capsule, or else the greater portion of the ovary down close to the hilum, is removed, so that the cut surface, which will be applied over the uterine horn, shall be through the ovum-bearing tissue. When most of the ovary is sacrificed, the other had best be saved to insure menstruation.

These changes from the original technic have been used during the last year. It is too early to determine how successful they may prove. The writer has been unable to find any record of a series of cases as extensive as his own. Of other procedures that may yield pregnancy, the introduction into the uterine cavity, through the uterine wall, of a portion of an ovary still attached to its pedicle, seems to have yielded encouraging results in the few cases reported (Dudley, Storer, Petit, Tuffier), though hysterectomy may be necessary later to relieve painful and profuse menstruation. The uterine wall-piercing operation may prove of special value

when inflammation involves the stump of the tube and the cornu. In tuberculous salpingitis, when the introduction of an ovary into the uterine wall might disseminate disease, an implantation would seem preferable.

W. W. WASSON, M.D.

Further Results with Ovarian Implantation. W. L. Estes, Jr. Jour. A. M. A., Aug. 30, 1924, p. 674.

Use of radium emanation.—If it is determined that the carcinoma is confined to the cervix and the vaginal wall, radium emanation tubes are inserted through the vagina, and this is followed by a course of high voltage roentgen therapy. In cases in which the broad ligaments are involved and fixed pelvic masses can be palpated, a laparotomy is performed. The patient is placed in the Trendelenburg position and the capillaries are inserted into carcinomatous tissue wherever it is found, *i.e.*, the broad ligaments, the spaces between the bladder and uterus, the spaces between the uterus and rectum, into the regional lymph nodes and also into the supravaginal portion of the cervix. The operation is followed in some cases by a severe reaction, with high fever, which generally subsides in a few days. In other cases no reaction follows and the patients make an uneventful recovery. The presence or absence of reaction does not depend upon the extent of the growth or the amount of radium emanation used, but is due to a combination of radium reaction and bacterial infection. After the patients have recovered completely from the effects of the operation, a course of high voltage roentgen therapy is given. The capillary tubes are sterilized either by boiling or by immersion in alcohol iodine and must not contain more than 0.2 to 0.7 mc. of radium emanation.

J. D. CAMP, M.D.

Intraperitoneal Insertion of Buried Capillary Glass Tubes of Radium Emanation in Carcinoma of the Cervix Uteri. Isaac Levin. Am. Jour. Roentgenol. and Rad. Ther., Oct., 1924, p. 352.

Cervical carcinoma.—At the University of Michigan, during the years 1902–1920, there were 380 patients with cervical carcinoma admitted to the clinic; during this period radium and X-ray were not used in this clinic.

Of these 380 patients, 60 were classed as early cases, and operated on. The remaining 320 cases were treated by caustics and cautery. All eventually died of the uterine malignancy, except one who was treated by excision of the cancerous cervix and cauterization. This patient was living three years and eight months after the operation. Of the 60 patients treated by radical operation, there was a primary mortality of 26.6 per cent, but 18 patients, or 40.9 per cent, are living and well five years or more after the operation. More recently, X-ray and radium have been used, but time and further experience are required to determine the results.

W. W. WATKINS, M.D.

End-results in the Treatment of Carcinoma of the Cervix. Roland S. Cron. Wis. Med. Jour., Aug., 1924, p. 128.

Diet for peptic ulcer cases.—In a new diet, recommended for the treatment of peptic ulcer, glucose-salt enemas are given throughout, and, for the first three to five days, only water is allowed by mouth.

Feeding by mouth is started on the fourth to the sixth day. The only foods permitted are olive oil or butter fat and white of egg. Later in the treatment, yolk of egg and cream may be added to the diet in replacement of a portion of the other fats.

The diet has been in continuous use for twelve years, and the results have proved satisfactory.

W. W. WASSON, M.D.

A New Diet for Peptic Ulcer. Warren Coleman. Jour. A. M. A., Sept. 20, 1924, p. 885.

Uterine conditions.—The efficacy of roentgen radiation of fibroids is reiterated, and the authors believe that unless there are complications which definitely indicate operation, radiation is the method of choice. According to the size of the patient and the tumor, the voltage is varied from 180,000 to 200,000, filtration from 0.8 to 1 mm. of copper and tube skin distance from 40 to 50 cm. With the higher voltage and the heavier filtration, the effective wave length is estimated at 0.138 A.U., the 10 cm. depth dose being about 40 per cent. The erythema dose at 50 cm. focal skin distance is 520 ma.-min., using a standard tube. The treatment is divided into four exposures with intervals of three or four days intervening. In most cases this will not result in any appreciable nausea. The ideal is to obtain the greatest possible diminution in size of the tumor in the shortest possible time, with the least possible inconvenience to the patient in respect to the number of treatments and with the least amount of radiation sickness.

There is, however, a very definite field for the use of radium, especially in those cases where curettage is indicated for diagnostic purposes and in patients whose age would render a future pregnancy impossible—in whom, therefore, any change in the intra-uterine structure would be of no consequence.

The fact that amenorrhea can be produced by comparatively mild roentgen treatment makes this method pre-eminently the one that should be used in the treatment of excessive or prolonged uterine hemorrhage, in which the usual medical and surgical procedures have proved of no avail and in which there is no objection to the production of a permanent menopause. In those cases of idiopathic menorrhagia in young women that do not respond to the usual surgical procedures, the hemorrhage can practically always be controlled by radiation and in many cases without producing more than a temporary amenorrhea. In these cases when the menses start again they are likely to be normal.

The best time to give treatment in this condition, as in uterine fibroids, is immediately after menstruation. The hemorrhage may be, and probably will be, increased immediately after treatment, but very quickly a marked improvement in the patient's condition takes place. In those patients in whom it is impossible because of constant flowing to determine the normal time of a period it is advisable to give very mild treatments, that is, even the castration dose is divided into two or three exposures. With these divided treatments results can usually be secured without special post-radiation sickness.

In metrorrhagia associated with the menopause, not due to malignancy, there is no objection to giving a full castration dose.

J. D. CAMP, M.D.

Treatment of Non-malignant Uterine Conditions. G. F. Thomas and W. C. Hill. Am. Jour. Roentgenol. and Rad. Ther., Oct., 1924, p. 357.

Menstrual studies.—While there is little difference of opinion at present concerning the uterine changes in the post-menstrual, interval and pre-menstrual phases, there has been much discussion for the last fifty years concerning the behavior of the endometrium during actual menstruation. The chief point at issue has been as to whether or not all or a part of the uterine mucosa is cast off. The paucity of reliable investigations on this point has been due in large measure to the aversion of surgeons toward operating on menstruating women.

Our material consisted of twelve uteri removed during some phase of actual menstruation, together with a number removed immediately before or just after menstruation. The study of this material, which we believe has been examined by methods eliminating errors of technic, convinces us that extensive loss of tissue is the rule during menstruation, as Schroeder has demonstrated. The entire superficial or compact layer, as well as most of the deeper or spongy layer, is thrown off. It is possible that there may be exceptions to this, but we have not observed them. On the first day, the surface of the mucosa may be quite intact, but more commonly it shows beginning loss of tissue. By the second day, the throwing off has become very extensive, all the compacta and most of the spongiosa being gone. Regeneration changes are usually evident on the third day, and may be quite marked.

The desquamation of mucosa is preceded by extensive infiltration with polymorphonuclear leukocytes and lymphocytes; this infiltration is marked for a short time before the actual clinical onset of menstruation. The throwing off of the mucosa does not usually occur as an extensive shedding in large masses. It is a sort of crumbling, molecular process, small strips and bits of granular degenerated mucosa being cast off until only the basalis, and perhaps a few spongiosal remnants, are left. The desquamated endometrial portions may be recovered from the menstrual discharge, as we have shown. Pyknotic changes are prominent at the beginning of menstruation.

Regeneration is remarkably rapid, especially the epithelization of the surface. The source of the new epithelium is chiefly the epithelium of the basal stumps of the uterine glands. Strange to say, mitosis is not a very frequent occurrence, appearing to a greater extent when the epithelial layer is already complete.

While diapedesis may, perhaps, play some part in the mechanism of the menstrual bleeding, rhexis is certainly the most important factor. It can be demonstrated histologically, although its occurrence is self-evident, in view of the extensive tissue loss associated with menstruation.

W. W. WASSON, M.D.

The Endometrium of the Menstruating Uterus. R. W. Te Linde. Jour. A. M. A., Sept. 20, 1924, p. 900.

Animal experimentation.—Thyroidectomy hastens, while gonadectomy delays, but does not permanently prevent, involution of the thymus. Suprarenalectomy alone not only delays involution of the thymus and lymphoid tissue but may cause their regeneration. Thyroidectomy prevents this reaction even after combined suprarenalectomy and gonadectomy. Suprarenalectomy plus gonadectomy is a more powerful stimulus for thymus and lymphoid regeneration than either of these influences alone. The combined effect of these two factors results in certain lymphoid and thymus hyperplasia in rabbits which persists until regeneration of accessory interrenal tissue corrects the physiological defect. The syndrome thus experimentally pro-

duced resembles status lymphaticus and is believed to depend mainly on a partial loss of certain functions of the interrenal and sex glands rather than of the chromaffin tissue. The normal and abnormal lymphoid and thymic hyperplasias of infancy and childhood are believed to be manifestations of a functional underdevelopment of the interrenal and sex glands of varying intensity. The so-called lymphatic constitution which underlies or accompanies exophthalmic goiter, Addison's disease, and acromegaly also appears to be dependent on a partial suppression of certain functions of the interrenal and sex glands.

W. W. Wasson, M.D.

The Influence of Thyroidectomy, Gonadectomy, Suprarenalectomy, and Splenectomy on the Thymus Gland of Rabbits. David Marine, O. T. Manley, and Emil J. Baumann. Jour. Exper. Med., Oct. 1, 1924, p. 429.

Malignant tumors of bones.—Multiple myeloma is a specific malignant tumor of the bone marrow, probably arising from a single cell type, and characterized by multiple foci of origin, a uniform and specific structure composed of plasma cells or their derivatives, rare metastases, albumosuria and an invariably fatal termination. Pathologically, there appear simultaneously grayish and reddish masses in the spongy bone or in the medullary canal, and as the masses grow they excite active resorption of the bone, in which there is great loss of mineral salts, with subsequent bending and breaking.

Roentgenologically studied, it is a slow-growing malignant tumor, the favorite site of which is the flat bones. The ribs, sternum, and pelvis are the chief original sites of the tumors, but the long bones are frequently involved. The lesions are multiple and the bones are pierced by small focal spots of destruction varying in size from a small bean to a ten-cent piece. The disease does not expand the cortex, but the gradual thinning and perforations allow pathological fractures to occur. After passing the periosteum, the surrounding tissues are invaded but this invasion is very slow.

The author reports one case together with the history, roentgenologic and pathologic findings.

J. D. Camp, M.D.

Multiple Myeloma, with Case Report. S. B. Whitlock. Am. Jour. Roentgenol. and Rad. Ther., Oct., 1924, p. 331.

Aneurysmal tumors.—1. Congenital aneurysmal tumors may arise from either the arterial or the venous plexus of the primary vascular anlage, or there may be a combination of both arterial and venous, resulting in (a) congenital venous aneurysm, (b) congenital arterial aneurysm, and (c) congenital arteriovenous aneurysm.

2. Congenital arteriovenous fistula is a definite clinical syndrome consisting of two types: in one of these, the continuity of the main vessels involved is not interrupted in the formation of the anastomosis; in the other, there is an interruption of the continuity of the main vessels forming the anastomosis.

3. All congenital blood vessels are due to a persistence of embryonic vascular channels, and are in no sense of the nature of a neoplasm.

4. The close association of hemangiomas and congenital arteriovenous fistulas is striking, and very suggestive that the etiology of them is the same.

5. The majority of cases of congenital arteriovenous fistula will be found to have multiple fistulous communications. These may lie latent for years before opening and becoming patent.

6. The local and general effects on the blood vascular system in congenital and acquired arteriovenous fistulas are similar in all respects, with the exception that there is no evidence of cardiac enlargement in the congenital cases.

7. A systolic murmur heard over the precordium occurs in any condition in which there is a leak of blood from the arterial system, and is not an indication of cardiac dilatation or myocardial insufficiency.

8. The injected pig embryos prove that the development of the blood vascular system is from a uniform capillary network or anlage rich in anastomoses, offering ample opportunity for the formation of an arteriovenous fistula.

9. The persistence of one of these communications between well developed arterial and venous trunks was caused by irritation, forming a true arteriovenous fistula.

10. Irritation of these endothelial elements, *in vivo* or *in vitro*, causes an abnormal development and growth.

11. In the area vasculosa, capillaries, at first carrying arterial blood, become carriers of venous blood, showing that a capillary can function normally regardless of the direction of the flow of blood.

12. The diameter of an artery decreases in direct proportion to the number of its branches that have been obliterated and, vice versa, increases in direct proportion to the total diameter of its branches, dilatation or diminution of the parent trunk occurring only up to the most peripheral branch affected, or, in the case of a false opening, to the most distant opening or fistula.

13. Complete interruption of the arterial and venous circulation results in a re-establishment of the arterial channels and flow before that of the venous.

14. The writer desires to suggest for the first time, he believes, that a simple nomenclature, as given under Conclusion I, should be used, discarding the confusing and inaccurate terms, such as aneurysm by anastomosis, cirsoid aneurysm, venous tumor and pulsating nevus.

15. He feels that complete excision of the aneurysmal tumor is absolutely necessary to effect a complete cure.

16. The case herein reported is the first case in the literature of congenital arteriovenous fistula in which the patient was successfully operated on and cured by operation; the only case in which multiple fistulous communications were ever demonstrated by actually dissecting them out and exposing them at operation, and the only case in which there has been demonstrated lateral communication between an artery and a vein.

W. W. WASSON, M.D.

Congenital Arteriovenous Fistula. William F. Rienhoff, Jr. Jour. A. M. A., Sept. 6, 1924, p. 743.

Mineral salts in relation to tumors.—In normal animals the introduction of mineral matter parenterally is followed by a reduction of the mineral matter of the blood, but when a tumor is present similar injections do not have that effect. However, the blood of a tumor animal shows demineralization, as does that of an animal bearing a focus of proliferating cells, which are not malignant, as in pregnancy. It may seem permissible, therefore, to class this phenomenon as one associated with the growth of cells within the organism. Injection of dead protein produces in the normal rat an increase in the total amount of potassium, calcium, and sodium of the blood and the same hypermineralization occurs in an animal bearing a receding transplanted tumor. Thus a disturbance of the salt metabolism is seen to be associated with growth as well as with death of cells. The question arises as to what causes demineralization of the blood and hypermineralization of local tissues, or hypermineralization of the blood and the demineralization of a group of cells.

Attempts to answer this question by inducing mineral salt changes in the animal have been unsuccessful. The authors conclude, therefore, that the use of any mineral salt as a therapeutic agent in cancer patients would not be justifiable on the basis of any experimental work carried out by them to date.

SOLOMON FINEMAN, M.D.

Studies on the Mineral Salts in Their Relation to Malignant Tumors. G. L. Rohdenburg and O. F. Krehbiel. Jour. Cancer Research, Oct., 1924, p. 423.

Irradiation of the abdomen.—From a study of the results in three cases, the authors are led to believe that intensive deep roentgen irradiation of the abdomen of a degree producing well-marked roentgen sickness produces lesions, not only in the gastro-intestinal mucosa but also in the epithelium of the biliary tract, particularly in the medium and smaller sized bile ducts. This injury is shown by the vacuolation, swelling and necrosis of the epithelial cells of these ducts, and by a slow and atypical regeneration, attended by the formation of syncytial giant cells, blocking of the ducts, resulting bile stasis and bile hemorrhage. Some injury to the liver cells at the periphery of the lobules is also produced, but the microscopic appearances of this are much less evident than those of the damage to the bile ducts. The liver cells appear to be more resistant to the irradiation than the bile duct epithelium. The disturbance of hepatic function after irradiation, noted by the authors, may be explained by these changes. The authors also believe that the hepatic as well as the gastro-intestinal injury must be considered as a possible factor in the production of roentgen sickness.

J. D. CAMP, M.D.

The Occurrence of Hepatic Lesions in Patients Treated by Intensive Deep Roentgen Irradiation. James T. Case and A. S. Warthin. Am. Jour. Roentgenol. and Rad. Ther., July, 1924, p. 27.

Radium in gynecologic practice.—Report based on 1,050 cases treated. There were 180 cases of leucorrhea, or chronic infection of the cervix; the discharge was always improved and 80 per cent were cured. Dose was 100 to 200 mg. h. In uterine fibroids, radium has a limited field, and is used in the uncomplicated, symmetrically developed, intramural fibroids not larger than a three months' pregnancy in women near the menopause. Two hundred seventy-five cases were treated, using 1,200 to 1,800 mg. h., heavily screened. Results were good in practically all cases, the amount of atrophy which resulted being surprising. In uterine hemorrhages at the menopause, radium is almost a specific. One hundred seventy cases have been treated, using 1,200 mg. hours, with double screen, since a minimum effect on the uterus and a maximum effect on the ovaries is desired. There were 235 cases of cancer treated, not commented on in this paper, and 120 cases of miscellaneous conditions.

W. W. WATKINS, M.D.

Radium for Non-malignant Gynecologic Diseases. Thomas J. Watkins. Wis. Med. Jour., Aug., 1924, p. 123.

Thymus gland.—In newborn infants who develop cyanosis, whether constant or intermittent in attacks, in the absence of other definite cause, persistent, large thymus should always be suspected. Such infants, even *in extremis*, should be given the benefit of X-ray or radium therapy. Plates should be taken before and after treatment, to follow results. However, negative plates do not mean "no thymus pressure," as it is anteroposterior thickness and weight of thymus, not width, which causes pressure, unless the symptoms are due to an endocrine substance.

Diagnoses of bronchopneumonia, obscure intracranial hemorrhage, and congenital heart disease should not be made without more seriously considering persistent large thymus as a cause of symptoms. Because of recent work indicating persistence of the thymus gland as a relatively normal condition, cessation of symptoms following X-ray treatment must be considered the more reliable criterion of diagnosis, rather than the "positive" X-ray picture. Treatment as outlined is advised, with careful follow-up records to establish most favorable dosages. The writers have found this treatment of definite value and believe they have lowered the infant mortality record thereby. Relief, while not immediate, occurs within a few hours, and the treatment is seemingly without danger.

W. W. WASSON, M.D.

Significance of Blood Nitrogen in Cases of Cancer of the Prostate and Bladder. B. S. Barringer and Ruth Theis. Surg., Gyn. and Obst., Oct., 1924, p. 490.

Calcification.—Calcification in adherent pericardium is not a frequent finding, but, when present, is almost pathognomonic. The authors present in detail four cases which are illustrated by drawings and roentgenograms. From a study of their material they have classified the deposition of lime salts in relation to the heart and pericardium, as follows: (1) Calcification in the pericardium itself—this is the simplest form and must represent the healed stage of a preceding infection; (2) calcification in both the pericardium and myocardium—apparently subsequent to an infectious process with a specificity for muscle, since in this type there may be no lesions of the endocardium; (3) deposition of calcium salts in the region immediately underlying the larger valves—this is the reaction to be expected following rheumatic fever.

J. D. CAMP, M.D.

Calcification in the Heart and Pericardium. E. C. Cutler and M. C. Sosman. Am. Jour. Roentgenol. and Rad. Ther., Oct., 1924, p. 312.

Experimental work in roentgen radiation.—Seven areas on the abdomen of each of fourteen rabbits were exposed to soft roentgen radiation of constant quality, in doses varying in the region of the value critical for the production of persistent alopecia, by regular steps of about 4 per cent. Without exception the critical dose was found to lie between two such values, the upper limit being represented by exposures on eight of the animals and the lower on ten of them. With certain reservations, the critical dose corresponds to the production of 2.04×10^{15} ions of either sign per gm. of tissue.

W. W. WASSON, M.D.

The Production of Persistent Alopecia in Rabbits by Roentgen Radiation: A Study of the Minimum Dose Required and the Consistency of the Reaction. Harry Clark and Ernest Sturm. Jour. Exper. Med., Oct. 1, 1924, p. 517.

Pulmonary tuberculosis.—Extrapleural thoracoplasty is an essential advance in the treatment of pulmonary tuberculosis. Surgical collapse should be promptly resorted to in all cases of pulmonary tuberculosis that fulfill the indications for artificial pneumothorax, when the latter therapy is impossible because of pleural adhesions. Thoracoplasty should be performed at a much earlier period in pulmonary tuberculosis to reduce the admittedly high mortality which is inevitable with late operation in an advanced stage of this disease.

W. W. WASSON, M.D.

Extrapleural Thoracoplasty in the Treatment of Pulmonary Tuberculosis. William H. Thearle. Am. Rev. Tuberc., Sept., 1924, p. 1.

Water-cooled X-ray tube.—A water-cooled X-ray tube has been used at the State Institute for the Study of Malignant Disease at Buffalo, N. Y., since the beginning of this year, under the following conditions: 200 K.V. peak, 30 ma., 0.48 copper filter. This tube has been running as much as six hours in one day and for over 150 hours altogether without any change. It has never given any trouble.

One hundred milliampere-minutes, obtained with 30 ma., produces approximately the same X-ray radiation as seventy-five milliampere-minutes obtained with 8 ma. The X-ray sickness immediately after the treatment is reduced. The erythema of the skin is produced by a slightly smaller dose as measured by the ionization chamber, when 30 ma. are used, than when 8 ma. are used.

SOLOMON FINEMAN, M.D.

Experience with a Water-cooled X-ray Tube for Deep Therapy. Wilhelm Stenstrom. Jour. Cancer Research, July, 1924, p. 285.

Phrenicotomy.—The decidedly favorable influence of the pulmonary rest and relaxation caused by complete paralysis of a hemidiaphragm in advanced tuberculosis strongly supports the suggestion that radical phrenicotomy, in conjunction with usual careful hygienic regimen, would offer to patients with predominately unilateral *early* tuberculosis, who are not making satisfactory progress under the hygienic regimen alone, a greater chance of early and permanent clinical cure than any other known method of treatment. It is deserving of trial.

W. W. Wasson, M.D.

The Surgical Treatment of Pulmonary Tuberculosis. Everett E. Watson. Am. Rev. Tuberc., Sept., 1924, p. 20.

Gall-bladder experiments.—The writer believes that when a magnesium sulphate solution is introduced into the duodenum, in the case of a healthy gall bladder, the bile reservoired there and consequently concentrated, dark and thick, is ejected into the space of the duodenum by the relaxation of Oddi's sphincter; under such conditions the contraction of the gall bladder occurs simultaneously. Sometimes, the B-bile starts to flow out because of the pressure of the bile stored in the gall bladder, and the obvious contraction cannot be seen.

Up to the present time, many opinions have been offered, and discussed in vain, because those who have presented them selected as an indicator the change in the color or the amount of bile, both of which are characteristic of normal bile. Since the change is occasionally only gradual and not striking, there may arise numerous questions. At present, we can conclude that the dark, so-called B-bile is truly the content of the gall bladder. Employing a foreign substance as indicator, *i.e.*, the typhoid bacillus in a typhoid bacillus carrier, the bacilli are found in the so-called B-bile and in the punctate of the same gall bladder.

Finally, the writer has observed with his own eyes that the fully expanded gall bladder becomes small, and he has noted the simultaneous recovery of the dark B-bile through the tube by means of the instillation of magnesium sulphate solution. Furthermore, he injected the dyestuff into the gall bladder and this was also ejected in an instant by the intraduodenal application of magnesium sulphate.

Indeed, he believes himself to be the first to have succeeded in visualizing, in the human body, the ejection from the gall bladder by the action of magnesium sulphate, of the dye previously injected into it, *i.e.*, he has demonstrated that the dye introduced into the gall bladder is ejected from it by the action of magnesium sulphate, because no trace of the dye is to be found anywhere else except in the gall bladder. Hence, the red-stained bile recovered must indeed be the content of the gall bladder and of no other organ.

For this reason, the result of his observation is fundamental and it is beyond all contradiction that magnesium sulphate instilled into the duodenum through the duodenal tube actually causes the evacuation of the gall bladder.

W. W. Wasson, M.D.

Magnesium Sulphate as a Cause of the Evacuation of the Gall Bladder. Iwao Matsuo. Jour. A. M. A., Oct. 25, 1924, p. 1289.

Ovarian symptoms.—If we accept the normal menopause as a control, the writer's analysis indicates that: (1) The frequency of vasomotor symptoms after hysterectomy is increased when both ovaries are removed. (2) The frequency of symptoms with conserved ovaries after hysterectomy compares favorably with that of the normal menopause. (3) Severe vasomotor symptoms are more common without than with ovaries. (4) The onset of delayed symptoms indicates that a definite number of conserved ovaries will atrophy within a year after operation. (5) The average duration of symptoms of the normal and surgical menopause is about two and one-half years. (6) Women with low hemoglobin are more likely to develop post-operative disturbances. (7) The frequency of symptoms depends in large measure on the type of tissue retained. (8) Retained healthy ovaries are not susceptible to degeneration.

W. W. Wasson, M.D.

Fate and Function of the Ovaries After Hysterectomy. Alice F. Maxwell. Jour. A. M. A., Aug. 30, 1924, p. 662.

Ovarian newgrowths.—Ovarian newgrowths may be clinically malignant, by causing implantation growths on the peritoneum and functional death of this membrane, with death of the patient, *e.g.*, the serous papillary cystadenomata; or they may be histologically malignant, like the carcinomata and sarcomata.

If, at operation, the growth is found to be localized, panhysterectomy is indicated; if not

localized, the cancerous tissue is removed as far as possible, unless clearly inoperable. Since even the apparently localized growths are seldom cured by operation, radiation is now being used post-operatively in all ovarian cancers, applying a 130 per cent erythema skin dose homogeneously throughout the pelvis. If uterus is not removed, radium is used, intra-uterine, 3,600 to 4,000 mg. h. being given. The serous papillary and pseudomucinous ovarian cystadenomata, causing transplantation growths on the peritoneum, should be treated in the same way.

W. W. WATKINS, M.D.

The Treatment of Ovarian Cancers with Combined Surgical and Radiological Methods. Henry G. Schmitz. Wis. Med. Jour., Aug., 1924, p. 125.